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EXPLANATORY NOTE.—Items in italics are names of books reviewed; illustrated articles are denoted by Asterisks (*); the letters (*m.d.*) refer to notices of articles under the heading 'Mining Digest.'

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

EDGAR RICKARD, *Managing Director.* H. FOSTER BAIN, *Editor.* EDWARD WALKER, *Assistant Editor*

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CONTENTS.

REVIEW·OF·MINING

Notice.—*The statistics and metal market reports, formerly found following our table of contents, have been moved back into the body of the Magazine in order to secure room for their expansion. They will be found on pages* 41 *to* 44, *and we trust that the new material printed will prove widely serviceable.*

Introductory.—The beginning of a new year is the accepted time for casting up the accounts of the old and forecasting the new. Under the separate countries we give such figures as are available in London at the beginning of the year bearing on the output for the past 12 months. It is evident that with few exceptions the year 1915 has proved unexpectedly good from a mining standpoint. Despite the handicap of the war, interrupted transportation, labour shortage, and increased cost of supplies, the mines have done well in the matter of output. It is an open secret that, though metal prices have been high, profits have not been in proportion. It is also appreciated that the demands laid on capital for war purposes have precluded the flow of new money into mining. Including Treasury Bills, Great Britain in 1915 subscribed and paid for £1,312,766,636 of new securities. Of this only £86,812,883 was for other than war purposes, and mining received only £21,500, with £22,100 going to oil companies, and £162,900 to coal, iron, and steel. Cuba, Argentina, and the Dutch East Indies were the only non-European countries outside the Empire that were supplied with money from London in 1915. There has been some trading in mining shares, but such expansion as has taken place has been merely the reinvestment of accumulated surpluses. Lately there has been fairly lively buying of seasoned shares, which indicates that those here and abroad who have made profits out of munition and other war contracts are having their attention attracted to the bargains on the mining counter. The year closed with good business in the share market, anticipatory to the large number of dividend payments that always follow the coming of a new year. The metal output for 1915 will be found large, for the reason that in this engineers' war metals are in demand. Gold has been needed in unprecedented amounts to steady exchange, and late in the year silver rose in sympathy. Germany is using iron coins, and in Belgium, the Vieille Montagne works at Liege are being run to produce spelter for subsidiary coinage. On this side of the fighting line, spelter, copper, lead, antimony, steel, and other metals have been used for munitions, but as yet coinage has been restricted to the usual metals. The year opens with vast armies in the trenches or in preparation, and vast works behind the lines supplying their requirements. In both spheres of activity mining engineers are doing their part with characteristic good sense and energy.

Transvaal.—The output of gold on the Rand during December was 755,101 oz., and in outside districts 26,010 oz., making a total of 781,111 oz., worth £3,317,949. These figures were almost exactly the same as those for November. The number of natives employed at the end of December was 209,438, as compared with 210,068 at the end of November, and 164,650 at the end of December a year ago. With regard to the labour figures, it is interesting to note that diamond mines are once more able to make a report. It is seventeen months since the production of diamonds was suspended. On July 31, 1914, the number of natives employed on the diamond mines of the Transvaal was 13,656. The return now issued shows that 132 were employed on December 31 just passed. This figure is not suggestive of great activity, but it may be taken as a promise for better things.

The output of gold on the Rand during 1915 was 8,772,919 oz. as compared with 8,003,567 oz. during 1914, 8,430,998 oz. during 1913, and 8,753,563 oz. during 1912. The total output in the Transvaal during 1915 was worth £38,627,461, as compared with £35,588,075 in 1914, £37,358,040 in 1913, and £38,757,560 in 1912. It will be seen that these figures for 1915 over the whole Transvaal are practically the same as those of the best year, 1912. The outside districts have declined, and the Rand has increased. It is noteworthy that the Rand figures are the highest in record, being £60,000 greater than in 1912, even though during the latter year gold to the extent of 70,143 oz. was taken from reserve and included in the current output.

The dividends declared by the gold mines of the Rand during the year 1915 totalled £7,516,313, as compared with £8,070,700 during 1914, thus showing a decrease of £554,346. It must be remembered however that during 1914, the total was augmented to the extent of £520,000 by the distribution of accumulated profits by the Robinson and Ferreira companies. The Crown Mines dividends were at the rate of 65% as compared with 85% for 1914, and 110% for 1913, this result providing one of the disappointments of Rand mining of recent years. Of all the big producers, Randfontein Central gives the poorest results, for nothing was paid in 1914, and though 2½% was paid in 1915, the additional capital raised by the issue of shares absorbed more than this dividend. As stated elsewhere, the Far East Rand provides all the hope for the future nowadays, and of the individual new mines in that region, Geduld, Springs, and Modder Deep are at present the most in favour, though Van Ryn Deep and Government Areas are also going strong.

The results at the Randfontein Central during 1915 have proved as disappointing as ever. The income from the yield of gold was £2,858,786, the working cost was £2,204,588, expenditure on shaft-sinking, etc., £217,000, development £103,000, debenture interest £171,648, provision for redemption of debentures £86,400, contribution to Miners' Phthisis Fund £48,600, profits tax £66,000, other rates and charges £55,900, total £2,958,136. During the year £150,000 additional capital was issued, and £108,592 was paid as dividend, being at the rate of 2½%. The balance carried forward is £48,420, as compared with £101,362 brought in from 1914. The directors inveigh in no measured terms against the Government assessment for profits and contribution to the Phthisis Fund, though to the outsider these items appear small for so extensive a property. A new method of working the mines during the present year is promised, presumably to consist of reducing the tonnage and selecting the ore.

In his speech at the New Modderfontein meeting Mr. E. A. Wallers, the chairman of the company, gave a straightforward account of the developments in the lower levels served by the new circular shaft. The ore so far disclosed is not so rich as in the upper levels, and moreover the proportion of profitable ore is smaller. An extensive campaign of development, both in virgin ground and in the large blocks already bounded by workings on four sides, will be necessary before a true idea of the average content and variation in content can be gauged.

The two collapses in No. 2 shaft at Ferreira Deep, in December 1914 and April 1915 respectively, had an adverse effect on the profits during the financial year ended September 30. The amount of ore milled during the year was 42,730 tons less, at 625,800, and the working cost £614,852 or 19s. 8d. per ton as compared with £585,930 or 17s. 6d. per ton. The fall in the grade of the ore mined also decreased the profits, for the output was £1,070,785 or 34s. 3d. per ton as compared with £1,236,631 or 37s. per ton. The working profit was £445,933 as compared with £650,701. The richer ore in the west part of the property is gradually being exhausted and a continually increasing proportion of lower-grade ore from the east section will in future be mined.

At the East Rand Proprietary, interruption to hoisting at Driefontein shaft was caused by a fall of rock. It has been found necessary to undertake an extensive amount of retimbering in order to guard against a recurrence of the mishap.

The scarcity of graphite supplies, hitherto imported, has encouraged production in the Pietersburg district. Foundry plumbago and black lead are now obtainable in the Transvaal from local resources, and the probability is that the industry will continue.

As foreshadowed last month, diamond production is to be resumed at De Beers. Washing operations were started once more at the Wesselton and Bultfontein floors on January 3. There is no present intention to reopen any of the mines.

The old mines at Ookiep, Namaqualand, worked for so many years by the Cape Copper Co., continue to yield well on the limited scale of the last few years. During the year ended June 30, the local smelter treated 85,000 tons, for a yield of matte containing about 450 tons of copper. This matte, together with 1025 tons of high-grade ore assaying 23·7% copper, was shipped to the company's works at Britonferry near Swansea. During the last three years the company has been developing the Rakha Hills mine in Chota Nagpur, India. The mining equipment and the concentration plant is nearly ready for a commencement of operations. The reserve of developed ore is estimated at 294,030 tons, averaging 4·2% copper. The capacity of the concentrator is 300 tons per day. At first it was intended to ship the concentrate to Britonferry, but the cost and irregularity of sea transport made the directors decide to produce matte on the spot, and a smelting plant is now in course of construction.

Rhodesia.—The output of gold during the month of November was worth £313,160, as compared with £339,967 the month before and £311,711 during November of last year. The Golden Kopje has not been able to maintain the big effort of August last when it was possible to pick ore that could be mined at a profit; during November £8974 was extracted from 9895 tons, at a working cost of £10,668, so that the position remains critical. The Shamva produced £34,901 from 46,567 tons.

The hearings in the Amalgamated Properties versus Globe & Phœnix case were resumed this week after a holiday rest, welcome doubtless to both judge and litigants. Cross examination of witnesses is taking an amount of time that seems wholly out of keeping with the results achieved.

India.—At the meeting of shareholders of the Champion Reef, Mr. Edgar Taylor outlined the plans for developing the mine at depth and expressed the hope that thereby richer ore would once again be found. Auxiliary shafts are being sunk to connect with the circular shaft, now called the 'Gifford.' This new main shaft for the lower levels has been completed, and besides proving of service for hoisting purposes has also had the effect of greatly improving the ventilation. Auxiliary shafts in Carmichael's and Glen sections are being rapidly sunk. It is noteworthy that on the 46th level a 1900-ft. run of high-grade ore has been developed.

The Mawchi Tin & Wolfram Co. has a new board, and Mr. D. J. Inskipp has gone out as manager. We trust he may have better fortune than his predecessors in putting the property on its feet.

Australasia. — According to the cable summary, Mount Morgan produced during the six months ended November 30, 62,779 oz. of gold, as compared with 58,196 oz. during the previous half-year, and 4310 tons of copper, as compared with 4482 tons. About 40% of the ore treated came from ground outside the estimated ore-reserves, a paradoxical condition that has ruled for some time now. The directors not inappropriately consider it desirable to make a fresh estimate of the reserve. A few months ago we recorded that a new orebody had been discovered in the Sugar Loaf section. At the time it was expected that a large source of additional ore had been tapped. Subsequent development, however, has falsified these hopes.

The copper mine of the Mouramba company, in the Cobar district of New South Wales, has suspended operations owing chiefly to lack of capital. The mine was originally worked by the Nymagee company, and reconstruction became necessary in 1910, when the Mouramba company was formed. The treatment plant includes a blast-furnace, and this was put to work a few months ago, but the smelting campaign did not last long. The ore reserve is estimated at 400,000 tons averaging 3% copper. The mine is 45 miles from a railway, so that costs are necessarily high. Local opinion favours a scheme for connecting a number of outlying copper mines with

Cobar by means of narrow-gauge railways, so that ore could be sent to the Great Cobar smelter, provided of course that this smelter reopens. The Mouramba is only one of a great number of low-grade copper mines in the district that individually cannot be made to pay.

The Mount Cuthbert copper company, operating in the Cloncurry district of North Queensland, has decided to proceed with the erection of a smelter and converting plant, according to the design of Mr. W. H. Corbould.

After being the subject of much negotiation for many months, the Chaffers mine at Kalgoorlie has finally passed into the hands of the Lake View & Star. Under the management of Mr. H. E. Vail, the latter company has paid satisfactory dividends on low-grade ore, found in the Lake View Consols and Hannan's Star mines, and shareholders in both companies may rest content that the Chaffers will be equally well handled.

A strike of wood-cutters has caused shortness of supplies at the power-plants at Kalgoorlie mines. The Golden Horse-Shoe has had to suspend mining and milling operations.

The Amalgamated Zinc (De Bavay's) company announces that it has sold 20,000 tons of zinc concentrate to Japanese buyers.

Malaya.—The new stamp-mill of the Chendai Consolidated, operating in the Kinta district of Perak, has commenced work. This company is of interest as it and its neighbour the Pusing Lama are engaged in working tin lodes. One of the properties of the company, the Red Hills, afforded subject for dispute as to the origin of the tin. It exemplifies the controversy between Mr. Scrivenor and Mr. W. R. Jones, who has contributed his views in the Magazine for October and December.

The dredge of the Kamunting company, operating in the Larut district of Perak, commenced work in the middle of March last, and during the 3½ months to June 30, the end of the company's financial year, had treated 333,000 cubic yards and extracted 209 tons of concentrate. The cost per yard is remarkably low, being only twopence, and will attract attention to the design of Mr. S. J. Weis and the constructional work of Fraser & Chalmers.

The Deebook Dredging Company is an Australian venture working alluvial tin ground in the Renong district of Siam, a short distance north of the state of Perak, and some of the shares are held in London. The first dredge started in August 1914, and a second a year later. From the beginning of September to the middle of October, the second dredge treated 69,549 cubic yards for a return of 40·7 tons of tin concentrate, being a yield of 1·3 lb. per yard.

Canada.—The *Canadian Mining Journal* estimates the gold production for 1915 at $8,000,000 as compared with $5,529,767 in 1914. The silver output is expected to be smaller, both as a result of lower grade ore being worked and low prices prevailing through most of the year. The nickel mines have been unusually busy; the copper mines, during the latter half of the year, have been pushed to capacity; and 1915 was signalized by the beginning of regular zinc smelting. On the whole, Canadian mining companies have done well. Details of the present situation are given in our Toronto letter.

At the end of the year it was announced that the Canadian Mining & Exploration Company would disband and return the capital to its shareholders. This company, though its main office was in New York, was composed of Canadian and American capitalists, and was the direct outgrowth of the success of Mr. Ambrose Monell and his associates at Sudbury and in Porcupine. It was formed to search for other properties, and sufficient capital, invested in standard securities, was allotted to it to permit the search to be conducted on income. It was in operation for three years, looked into about 1500 properties, and took hold of nothing. As others during the same time did find properties in which they were willing to risk money, there would seem to be point in the criticism of the man in the street that the management wanted only sure things and was unwilling to accept a risk. It is not that way that a mining business is built.

Molybdenite in blocks of gneiss found near Skagway on the White Pass road lead to the discovery last fall of a 50 ft. vein of pegmatite impregnated with the mineral. How important it will prove is not yet certain. The Canadian Klondyke season closed on December 11 with a total output of 67,382 oz., compared with 68,973 oz. won in 1914, closing December 12, and 86,574 oz. in 1913, closing December 26.

United States.—Prosperity is everywhere apparent in this country. Excellent crops at high prices have been reinforced by a growing foreign trade only hampered by scarcity of shipping. The shipyards are full, 761,000 tons being under construction, railways are congested, and orders for steel and iron are so heavy that blast-furnaces and steel mills are working at full capacity. Lake Superior iron mines shipped 46,000,000 tons of ore in 1915, and are preparing to send out 55,000,000 to 60,000,000 tons in 1916, though it is doubtful if boats will be available for the larger amount. The gold, silver, copper, lead, and zinc outputs for 1915 will doubtless show substantial improvements. We review on another page the recent work at three of the big copper mines. Advance estimates made by the United States Geological Survey indicate that the value of these metals produced in Montana, for example, amounted to $87,000,000, an advance of 81% over the figures for 1914. The gold output is estimated at $5,000,000, an advance of 21%; silver came to 14,500,000 oz. as against 12,016,000; copper amounted to 275,000,000 lb. as against 233,229,640, an 18% increase; lead increased 45% or from 9,656,000 to 14,000,000 lb.; zinc went up 61%, from 111,580,544 to 184,086,000.

The Anaconda company, which has been experimenting for a year or more with a wet electric process for zinc recovery, is to go into the business at once on a large scale. The process involves grinding to 40-mesh, followed by a dead roast and leaching with sulphuric acid. The solution is then purified by using lime to neutralize it and precipitate the iron, after which the copper is brought down by means of zinc dust. The purified solution is run over an Oliver filter, and the zinc taken out of the clear solution by electrolysis, using insoluble lead plates for anodes and either aluminium for cathodes or starting sheets of zinc that have been deposited upon aluminium and stripped. The spelter made is of high grade, and production has been for some time maintained at 10 tons per day. The plant at Anaconda is to be increased at once to 25 tons capacity, and a new plant, to be ready next September, is being built at Great Falls to produce 70,000,000 lb. spelter per annum. To feed it an 'all flotation' zinc concentrator is being erected.

The Black Hills gold mines yielded $7,390,000 compared with $7,333,508, and the Homestake Gold Mining Co. not only paid its regular dividend of 65 cents per share per month, but an extra of $1, the total for the year being $2,200,008, and the total to date $40,468,052. In Colorado, Mr. C. W. Henderson, of the Survey, estimates the gold output at $22,300,000, the silver at 7,080,000 oz., lead 66,664,000 lb., copper 7,100,000 lb., zinc 100,000,000 lb. These figures show a total value of $43,100,000, a substantial increase over the value for 1914.

In May last we recorded that the directors of Stratton's Independence Ld. recommended the sale of the company's property to the Portland Gold Mining Co. The Chancery Court has now given permission for the reduction and return of capital following this sale. Now that the reduction has been permitted by the Court, it will be possible to test other properties, of which Mr. Philip Argall, the company's consulting engineer, has several in view.

The life of the Camp Bird mine promises to be considerably extended owing to the favourable results of development on the 9th level of the ore-shoot worked from No. 3 shaft. As the limit of the capacity of the equipment at this shaft had been reached at this level, the question as to the method of further exploration at depth had to be considered. Messrs. J. A. Agnew and W. J. Cox agree that it would be best not to sink an auxiliary shaft or remodel the present shaft, but to drive an adit, calculated to cut the lode at a point 450 ft. below the 9th level in this part of the mine, and 800 ft. below the workings in another section. This adit will be 10,700 ft. long. Its cost is estimated at £40,000, and the time occupied in its construction 27 months.

Mexico.—It is impossible to give even approximate estimates as to the mineral output of this country in 1915. In a memorial recently presented to the Carranza government by foreign mine owners, it was stated that not more than 3% of the mines of the Republic were working. There has recently been some resumption, and the smelters are shipping-in a stock of coke, but with heavy and uncertain taxes hanging over their heads the mine owners are not disposed to rush matters. Politically the air in Mexico is clearer than at any time since Madero's triumph. Villa issued a manifesto announcing his withdrawal from the fight, a number of his generals have surrendered, others have been captured or are in full retreat. Zapata is the only unconquered chief of note, and his force consists, for the moment at least, of a small band roving in the mountains. If Carranza would only rise to the occasion, peace of some duration may be anticipated in Mexico.

At the meeting of shareholders in the El Oro Mining & Railway Co., Mr. R. T. Bayliss delivered one of his usual business-like speeches. He was able to say that the property had been kept intact, and that sufficient work had been provided, since hoisting was suspended in February last, to keep the local population from starvation and mutiny. Though conditions in Mexico showed signs of improvement, any idea of resuming operations was out of the question at present. He would not advise resumption unless there was a reasonable assurance that operations could be continued unmolested for an indefinite period. It is no doubt exasperating to shareholders that this enforced inactivity should come at a period of the company's history when the prospects had become brighter once more owing to the excellent state of the ore reserves in the Ofir and Somera claims, but it was ungracious for a shareholder to propose a drastic reduction of the directors' fees while the mine was not working, especially as the board had already decided to waive 33⅓% during the period. Most of the shareholders consider themselves fortunate in having so well-qualified and hard-working a chairman as Mr. Bayliss, to guard their interests and formulate the policy of the company, at the low fee of £400 per year.

South America.—The beginning of the New Year finds mining expanding rapidly on the west coast. At the Braden mine in Chile new equipment is being brought into use with a consequent great increase in production at the same time that the shareholders have promise of immediate dividends by reason of the amalgamation of the company with the Kennecott mines in Alaska. At Chuquicamata production is proceeding, though there are ill-defined rumours that power consumption is exceeding estimates. The nitrate mines are resuming, and the Bolivian tin mines have more market for their ores than before the war as a result of the completion of the new Guggenheim smelter near New York. Perhaps the most significant announcement, following a note in our issue of August last, is that the Anaconda Copper Mining Co. has taken over a large copper property in northern Chile, brought to their notice by Mr. William Braden. The Anaconda, the largest individual copper producer in the world, has always shown a strong disposition to stick to home enterprises. It is said that when Haggin took over the Cerro de Pasco, he offered participation to Rogers and others of the present Anaconda group. They declined, and he went to J. P. Morgan for help, the two of them carrying the enterprise to fruition.

Panama.—On January 1 the Canal was still closed, to the great inconvenience and cost of shipping. It will, however, soon be re-opened if not ready when this reaches the reader. It may give some definite idea of the task involved to say that the slides during September 18 and 19 last put 10,000,000 cu. yd. of material, covering 175 acres, in motion. The dredges accordingly have been more than busy and have been establishing new records. One Bucyrus 15-yd. dredge handled 17,185 cu. yd. in 24 hours (October 5), and other records of 14,650 and 15,145 have also been made.

Congo.—Unusual interest has been attracted this year to the Congo because of its ownership by Belgium. We are glad to report that the colonial enterprises have all done well this year, save possibly the steamer lines which have been subjected to most unusual difficulties. Among the mines, those at Katanga, controlled by the Union Minière, and in which Tanganyika Concessions has a large interest, naturally come first. Here the three 48 by 192 in. blast-furnaces produced about 15,000 metric tons of copper. By February, two additional furnaces 42 by 240 in. should go into blast, and an output of 22,000 to 25,000 tons is anticipated for 1916. The present cost of the copper laid down in London and aside from amortization and interest, is £42 per ton. On the projected scale of work for 1916, it is expected that this will be brought down to £33. Ninety per cent of the ore now comes from the Star of the Congo and the Kambove mines, and assays about 15%. Diamond-drill work on other properties is in progress, and Mr. Arthur E. Wheeler is conducting leaching tests on low-grade ore.

The Forestière et Minière company, in which Americans are joined with Belgians, has finished its reconnaisance work, and is busy developing gold and diamond mines. So far the diamond digging has been confined to river and alluvial work, nothing having been done in the pipes. About 50,000 carats was exported last year, and the known reserve was greatly increased. Gold mining in the Congo is conducted in part by the State. The total output may be estimated at £375,000.

Late in the year, there were repeated rumours in New York and London to the effect that the Americans were investing in Congo companies, and a few Stock Exchange transactions confirmed this. Control of the Congo companies is, however, closely held, and the Belgians, like South Americans, are not apt to deal except with old friends. Also it is not the American manner to attempt to gain control by open buying in the market. A deal between principals is more customary, and in this case we have observed no disposition on the part of the Belgians to jettisonize.

Russia. — Late in the year Orsk shares made a spurt in the London market upon rumours of an impending dividend. The Orsk, it will be remembered, is a Hooper-Speak company operating two gold dredges in eastern Siberia. The property was found by C. W. Purington and has had the services of several excellent engineers, but so far only paper profits have resulted. This year drastic cuts have been made in expenses, mainly through substituting native for foreign labour, and, while final results are not at hand, it is estimated that the Kolchan dredge, which is the larger one, operated 222 days at a cost about 1½d. per yard less than in 1914. The Pokrovsky ran only 188 days and on account of the smaller yardage the cost was 4d. to 5d. more. The Kolchan handled 60,000 cu. yd. of gravel in November, yielding Rs. 50,000. The total yardage for the year was 782,650 and the yield, at Rs. 9·50, approximately £69,000. This may be compared with 710,100 cu. yd. and £63,117 in 1914. The costs quoted cover administration in Siberia, but not in London. These figures, while approximate only, indicate a yield per yard fully up to that of 1913, presenting a substantial recovery from those of 1914. Evidently progress is being made.

The Tanalyk Corporation has recently developed a new property. This is the Tuba, about 25 miles to the north of the other mines, and it contains an oxidized outcrop which has been traced for 1000 ft. By shafts and a drift at 60 ft. deep, a length of 270 ft. has been already proved. The average width has not been determined, but at two points the widths are 40 ft. and 12 ft. respectively. Samples taken along 160 ft. of the drift gave an average assay of 76 dwt. gold, 23 oz. silver, and 1·1% copper. The orebody is apparently an enriched gossan outcrop of a pyritic lode, and is similar to that at Semeonovsky.

Notable Deaths.—Sir Henry Roscoe, who has died at the age of 82, was the great pioneer of chemical and technological education and research in this country. He was the great force at Owens College, Manchester, which he made the prototype of modern scientific centres of study. To metallurgists he was known as the discoverer of vanadium, and the credit for the commercial success of the electrolytic soda industry is to be largely attributed to his sagacity. 'Roscoe & Schorlemmer' is still the standard text-book for students of chemistry.—News is to hand of the death of Orville A. Derby, who as geologist to the Brazilian Government for many years did much excellent work. His labours in connection with the elucidation of the iron, gold, and diamond deposits were of great advantage to the State.

EDITORIAL

CONGRATULATIONS are due to Mr. H. W. Hardinge on having been the recipient of the John Scott medal and maximum cash premium conferred by the Franklin Institute for the invention of the conical mill. The John Scott who founded the medal in 1816 lived in Edinburgh, so that an American scientific institution, through the munificence of a Scotsman, is thus able to honour an inventor who has done service to the world.

MISPLACED decimals have wrought havoc more than once, and an even more complicated error lead us to translate wrongly dredging costs on the Pavoda Estate, in our review of mining for November. The Russian figures, 3 roubles per cubic sagene work out to a trifle less than 6 pence per cubic yard. Even these we understand are outside figures, the actual cost being materially less.

COLUMBIA School of Mines has many loyal graduates scattered among the mines. One of them, Mr. Benjamin B. Lawrence, has just evidenced his affection for the school by buying and presenting to it the Pelton-Doble water wheel and Pelton-Francis turbine exhibited at the Panama Pacific Exposition. Some other graduate should now present a waterfall. We believe it is on record that a donor was once brought to give a dam to the State University of Iowa, which suggests possibilities.

DECISION of the Court of Appeal favourable to the Zinc Corporation in the action for annulment of pre-war contracts with German ore buyers has been announced since we last wrote. The matter is subject to further appeal, but officers of the Corporation are confident that the decision will stand. Separate action in British Courts was necessary in the case of the Zinc Corporation as it is a British company. The other Broken Hill companies, being Australian, are controlled by local legislation, of which our Melbourne correspondent writes. Plans are in hand for the establishment of a large zinc smelter in Great Britain to treat the ores of the Empire, but details cannot be given at this time.

BROKEN HILL is troubled with a strike, the men objecting to giving up their Saturday half-holiday, despite the needs of the Empire and the present demand for metal. We should think that they had had enough idleness since the war opened, and we hope better counsels will prevail.

THE CASSEL Cyanide Co., of Glasgow, is a company that should take pleasure in paying excess profits tax, for the suppression of the German article, as far as the British Empire is concerned, gave it a welcome advantage. The divisible profit of the company for the past year has greatly increased, even after paying the excess profits tax, the shareholders receiving a dividend of 110%.

OUR contemporary *The Engineer* completed its sixtieth year of publication with the issue of December 31, the first number having appeared on January 4, 1856. In its early days, *The Engineer* had as its editor, for a short time, the celebrated 'calculating boy,' Zerah Colburn, who subsequently was the first editor, also for a short time, of *Engineering*, established in 1866. The permanent success of *The Engineer* was due to the late Vaughan Pendred, who occupied the editorial chair for nearly fifty years, a position now worthily held by his son, Mr. Lough Pendred.

DISCOURAGING tales come to us from time to time of engineers, a bit over age perhaps, who have difficulty in getting into war work. Sorting out the men of a nation after a war starts is too big a job to be done without some mistakes, but experienced mining engineers have so many points of availability that it would seem that there should be some place for each one offering. We hear of two who have given up trying, and have gone into chicken farming. Perhaps after all adding to the nation's food supply is as patriotic work as any.

RUSSIA has come much nearer to all of us as a result of the war, and the tales of hardship and brave endeavour told on another page by Mr. E. T. McCarthy will be read with especially sympathetic interest. We are glad to note that in the work of caring for the refugees from Poland a group of mining engineers, this time British, is playing a leading part, just as in feeding Belgium another group, which happens there to be American, is playing an honourable part. In Moscow the Spassky Copper Mines Ltd., in co-operation with their staff, built a 70 by 56 foot soup kitchen where 1000 meals are served daily. Mr. Woolmer, Chairman of the Moscow Committee, is manager in Russia for the Spassky Company, while Mr. McCarthy, who tells of the work and acts as London Agent for the Committee, is Consulting Engineer for several Anglo-Russian enterprises. When the history of these years comes to be written the part played by mining engineers both at the front and back of the lines will be seen to have been large and honourable.

COST comparisons are always interesting, and Mr. J. F. B. Erdlets, using Skinner and Plate's 'Mining Costs of the World,' has compiled certain averages that are worth keeping in mind. They are of working costs only, excluding amortization, depreciation, and general office expenses. All are based finally on company reports, and are for a period of one year. Mr. Erdlets finds that 169 mines of all classes treating a total of 133,879,500 tons, averaged \$1·73 or 6s. 9½d. per ton for mining. On the Rand 32 companies treating 18,923,000 tons showed a cost of \$2·59 or 10s. 9½d. In America 7 'porphyry coppers' mined 22,363,000 tons at a cost of 49c. or 2s. 0½d. Milling costs for 128 mines of all classes, treating 35,265,500 tons, averaged 75c. or 3s. 1½d., while the cyaniding cost covering 50 mines and 14,050,145 tons was 49c. or 2s. 0½d. The smelting cost, per ton of charge, on 4,998,258 tons at 16 plants, averaged \$2·31 or 9s. 7½d., while gold dredging, 7 boats and 51,024,983 cu. yd., cost 4½c. or 2¼d. per yard. Such general figures are only of general value, but it is interesting to find that mining Rand ore costs a little more than smelting American copper and lead, while cyaniding gold ore and mining 'porphyry' copper is about equally expensive. The extremely low cost of gold dredging is apparent, though as to that the line between operating and capital charges is particularly difficult to draw, and operating dredging costs are especially deceptive.

Glass Surfaces in Concentration.

The character of the surface used has long been recognized to be important in concentration on tables. In the case of the old wooden frames, the differing degrees of hardness of the various tissues leads to an irregular surface, in the pits of which the grains of concentrate accumulate. If the surface is not sufficiently irregular it is dressed from time to time with a stiff wire brush. The distribution of high and low spots is, however, haphazard, and depends upon the grain of the wood. Attempts have been made to obtain suitable surfaces on which the high and low were regular and subject to control. Artificially roughened cement, woven cloth, belting, and various other materials have been employed. Frosted and fluted glass surfaces have been tested, in America on the Deister tables, and in Cornwall on revolving frames. We gave last month a summary of the patent claims made by Mr. W. Morley Martin, whose tables are being tested in a number of the mills of Cornwall. This month we present, through the courtesy of Bewick, Moreing & Co., a summary of a test made at the East Pool & Agar, where Mr. M. T. Taylor is the accomplished superintendent. In considering these figures we would warn our readers first that the test, while competitive, was made in an existing mill on one of the mill products. At best it affords a measure only of the effect of substitution of glass for modern surfaces at one point in the present flow-sheet. It is quite possible that substitution at another point in the mill, where a different product would be handled, might give entirely different results. It is also to be remembered that the slope of the frames used in the test was fixed. It is quite possible that in using a glass surface best results can only be obtained if the slope and the classification be somewhat different from that which experience has dictated for wooden table tops. This is an old problem, but one not even yet sufficiently appreciated by engineers. When a new piece of apparatus is tested in competition with an old one, but dividing the feed, the test merely shows whether or not the new apparatus is better under conditions found best for the old; it does not show whether it is capable of giving better results under conditions similarly determined as best for the new apparatus. The result indicates whether it is wise to substitute the new machine or device without other change in the flow-sheet. True enough it is that often to make extensive alterations in the whole mill in order to conform to the requirements of a new device is not feasible, but until adequate preliminary studies be made, and enthusiastic inventors are often over anxious to demonstrate in a working mill, it is impossible to say how extensive either changes or benefits may be.

In the second place it is to be noted that the concentrate made on the table is an intermediate product in the whole process of tin dressing. Manifestly, having regard to subsequent treatment charges and losses, there is considerable difference between a smaller amount of higher grade concentrate and a larger amount of low grade. There may be profit in accepting the extra tailing loss and obtaining the higher grade concentrate. Indeed, Mr. Durwood Copeland found at the Llallagua tin mine in Bolivia that raising the grade of concentrate from 60 to 70% resulted in profits greatly exceeding the extra cost and tailing loss. To make perfect extraction it is only necessary to do no concentrating; all the mineral is then saved, though in a bulky concentrate. One factor which makes the bulk of the concentrate important is that in Cornwall the value of the concentrate is not determined alone by the percentage of tin present. Wolfram, arsenic, silica, and other minerals must be taken into account to an extent not generally appreciated by those not personally familiar with the mines and mills. When all these matters are considered it will, we believe, be recognized that final conclusions as to the value of glass-top tables can hardly be drawn even from so careful a test as that of which we present the results. This, we need hardly add, is fully recognized by the management of the East Pool. A number of other tests have been made in Cornwall. While we are not permitted to quote them, we may say in a general way that the results are contradictory, and we conclude that, while the glass-topped tables offer distinct probability of value, a complete scientific study of their applicability is yet to be made. We shall recur to the subject, but in the meantime hope that this generous publication of technical information by the managers of East Pool may have the effect of leading other Cornish companies to pool their knowledge for the common good.

Minerals Separation.

Flotation is much to the fore these days and accordingly we are giving large space to it this month. The decision of the District Court in the Miami case will probably have been announced before this reaches the readers, and the United States Supreme Court is expected to pass upon the appeal of the Hyde case within a few months. Whatever may be the results of the litigation, flotation itself is being widely adopted. In his address to the shareholders of Minerals Separation Ltd. at their tenth annual meeting held just before Christmas, Mr. John Ballot, managing director for that company, gave interesting details as to the extent of use of the process. The Australian operators, as is well known, early adopted flotation, which has been a most important factor in rendering available the great reserves of metal at Broken Hill. The introduction of the process elsewhere was slower but, according to Mr. Ballot, 46,000 tons of the spelter produced in the United States in 1914 and about 110,000 of the output for 1915 was from ores treated by flotation. Altogether Mr. Ballot estimated that the licensees of

Minerals Separation and affiliated companies treated 4,500,000 tons of ore in 1915, and early in 1916 mills would begin operations that would raise the output to 13,000,000 tons. This estimate does not include the output of any one of the hundred or more companies that have as yet refused to take a license from Minerals Separation. In America, at least, the field for flotation which is developing most rapidly is in connection with copper production. The Anaconda Company expects to have completed and started the last of its eight 2000-ton per day units by the middle of the present month. By the end of the year the Inspiration Company, now treating 7000 tons per day, should have its capacity up to 15,000 tons. The Britannia Company in British Columbia has completed the first 1000-ton unit of a 4000-ton mill, and the Braden Company in Chile should by now have completed the extension of its plant from 3000 to 4500 tons per day. At Cripple Creek, where some 11,000,000 tons of dump ore is available, the Portland Gold Mining Company has taken a license and is erecting a plant with a capacity of 2000 tons per day of gold ore. The Anaconda Company is going in for zinc, and by September expects to have completed an all-flotation mill to treat 1200 tons per day. The agreement between the Anaconda and Minerals Separation provides for minimum royalties amounting to $300,000 and if, after the Supreme Court hands down its decision in the Hyde case, the copper company does not exercise its option to return its license, a further minimum payment on 25,000,000 tons of ore before November 1923, is stipulated. Evidently flotation will be used in a large way however the Courts may hold as to royalties. At Anaconda, it is stated, the recovery has been increased from 78 to 96%, and the extra copper saved each year will amount to 47,931 tons, or approximately the total annual output of Australasia. Tailing at Anaconda, since flotation has been used, contains only 2 pounds of copper per ton. This improved extraction increases the ore reserve and the consequent value of the mines, just as happened at the Homestake when Mr. C. W. Merrill worked out the cyanidation problem there. This is most practical conservation. Mr. Ballot presents figures to show that application of the flotation process to the ores of the Utah, Ray, Chino, Nevada Consolidated, and Miami mines, at all of which the process is either in use or has been tried, should result in increased recovery to a total of well over 53,000 tons per annum, roughly the equivalent of bringing into production mines equal to all those in Spain and Portugal. The profit on this extra copper will be large, since the major mining and milling cost has been already met. Carrying the matter further it is shown that the five mines mentioned, with the Inspiration, have in reserve 660,000,000 tons of sulphide ores. Two other Arizona mines add 50,000,000 tons, and the average copper content for the whole is 32·5 lb. per ton. Without flotation the average recovery is 67·6%. If this be raised to 90% by flotation, 2,582,000 tons of additional copper may be saved which at 14 cents would be £72,000,000 increased return. These figures give a notion of the quantitative importance of the process.

Despite the long, vexatious, and expensive litigation that the company has had to face, Minerals Separation closed the year in good financial condition, though the larger part of the money so far earned has been expended upon law costs. The remainder, it is felt, should be held until more settled times, but dividends in 1916 are suggested.

A Decade in Economic Geology.

Ten years ago, writing in another *Mining Magazine* published in another city, it was our pleasure to review the status of economic geology, particularly in the United States, at the end of the year 1905. Turning over the pages of that old review, one is impressed with the fact that in the intervening years the geologists have been by no means idle. It has been an interesting and fruitful decade, though no great new fields comparable to the Rand, the Klondike, or California have been discovered. The Rand itself has enormously increased its production, and the Far East Rand has been brought within the domain of practical operations. The Congo, too, has been explored geologically and gold, copper, and diamonds are now coming out in constantly increasing streams. Within the decade the Broken Hill zinc deposits have changed the whole current of spelter trade, Japan has begun the export of finished copper products, and Russia has been discovered by the adventurous spirits who take capital into the wilderness. In America it has been an era of big things, among which the porphyry coppers stand out. Eastern Canada has found herself and added Porcupine to Cobalt. Mexico, despite five years of civil war, developed enormously in the period as a whole, and in South America, the Brazilian iron ores have been explored and made ready for production, while on the West Coast of South America, copper deposits have been laid under tribute on an enormous scale. In a practical way, the period has been one of most remarkable mining development.

In theoretical work, while results have been less striking, they have perhaps been equally significant. While the germ of most of our present day ideas regarding ore deposits was then present, while indeed the outlines of accepted theory regarding genesis and occurrence had then been clearly limned, there has been immense accomplishment in the filling in of detail and, it is fair to add, professional geologists feel much more certain of the ground under their feet than they did ten years ago. The general theory of the genesis of ores has not been greatly changed. The close association of igneous activities with the types of ores that mainly concern readers of *The Mining Magazine*, is perhaps more generally recognized, and much more is known as to how the processes which form igneous rocks, as an incidental result also form ore deposits. But the main processes had then already been recognized. So too the 'secondary enrichment' ores now so widely discriminated and so generally accepted as of first economic importance, were then already known, it having been in 1900 that Van Hise, Emmons, and Weed gave definite form to a theory already foreshadowed by De Launay. In the years since, secondary enrichment has been the magic wand of the conjuring promoter; it has also, in certain properties, been the sure guide for secure financing and sound technical direction; but secondary enrichment has also proved an inconclusive and tantalizing will-o'-the-wisp to those whose work lay with other deposits. Sure criteria for discriminating between primary and secondary minerals have proved in part elusive, as is clear to any one following the studies of chalcocite at Butte. The greatest progress made in this particular field has flowed from the study of opaque sections of ores in reflected light. This work began just ten years ago, for in the first volume of that most valuable journal *Economic Geology*, Mr. William Campbell illustrated the method and its application to the study of the Sudbury ores. The possibilities of such work were unfortunately not appreciated, and it is only in the last three years that a considerable number of students of ore deposits have taken it up. How fruitful it may become has already been demonstrated by Mr. L. C. Graton, Mr. C. F. Tolman, and others. Probably the most important step made is the growing recognition of types among ore deposits. This has been so widespread that it would be impossible to allocate credit or even to suggest leadership, but it is proper in this connection to refer to Mr. Waldemar Lindgren's numerous papers, and especially his work on 'Mineral Deposits' as illustrating this tendency. The effort to work out criteria for discrimination of types was also greatly helped by Mr. W. H. Emmons' work on the genetic classification of minerals, and the synthetic studies made by Messrs. Day, Allen, and Wright at the Carnegie Geophysical Laboratory. It is perhaps significant of the change in emphasis, in America at least, that whereas ten years ago this brilliant group of workers was concerned with felspars as the chief rock-forming minerals, it has for some time now been studying sulphides, ore-forming minerals. The finding of critical minerals, such as wollastonite, made possible the construction of a rough geological thermometer, and hence Lindgren's discrimination of ore deposits according as they were formed at high or low temperatures, and shallow or great depth. The reaction against the tendency to refer matters to activities of meteoric waters has been pronounced and, in our judgment, has gone too far. Those of us who would save a few types from the all-invading magmatic waters have been forced back until, like the Serbians, we are left almost no space for a fighting line, though our valiant friend, Mr. A. C. Lawson, proves a veritable King Peter. It will be interesting to see what the next ten years brings to pass as regards belief on this point.

One most fruitful line of research, one that we believe has been over slow to obtain recognition, is colloidal chemistry in its application to ore deposition. It is many years since Mr. W. H. Weed studied the hot springs of the Yellowstone and Ostwald put out suggestive ideas in the days when most of us wore aprons in chemical laboratories, and yet until Messrs. E. Hatschek and A. L. Simon read their paper before the Institution of Mining and Metallurgy in April, 1912, the subject received no general attention among English speaking workers. In Germany, Krusch and his associates had long been working along these lines, but in America, usually so quick to grasp new ideas, the possibilities of colloids are even yet less appreciated by the geologists than by workers in ore-dressing.

The last ten years has seen the failure, for the present at least, of one line of research that promised much, namely regarding the geological effects of radio-activity. Nothing very tangible has so far come from this fascinating subject of study. The impetus, too, given to igneous theories of oil genesis by early studies of the Mexican oil deposits has received a check. Here as in general it is found that structure is the most important factor in planning the actual exploitation of deposits, and one of the striking features of the last decade has been the growth in demand for trained economic geologists, to work with the operating men in actual mining. This, which we noted as already begun in 1905, is now one of the accepted conditions of business to-day. The geologist is no longer regarded as a bewhiskered and spectacled supernumerary, but has become an integral part in the machine that does the day's work. The young man on the firing line has given up something mayhap of an early disposition to settle matters *ex-cathedra* on the basis of theory, and, by patient tracing of outcrop, and mapping veins, cracks, and drill-holes, has won the sincere respect of his fellows of the operating staff. The long established combination of book-keeper and assayer on small properties is being supplemented by the surveyor-geologist, while with larger concerns the geologic corps is as distinct an organization as the metallurgical. This is as it should be, and we trust that the young men in the field will recognize that they have in their keeping the honour of a great profession, and understand always that it is equally important to be an authority in one's specialty and not to pose as an authority where one is not a specialist. If this be kept in mind we have no fear that, if it be our good fortune ten years hence to write another review, we shall be able to record that the economic geologist is still more useful, and as a result more deeply entrenched in the respect of his professional associates.

Porphyry Coppers in War Time.

Among the lessons already afforded by the war there are few relating to mining that are of larger potential interest than those that may be drawn from the experience of the so-called 'porphyry copper' mines in the United States. Development of this type of mining ore, based upon the application of 'wholesale' methods, is one of the most significant achievements of recent years. By doing on a large scale what had previously only been attempted on a small one, and by introducing adequate capital, mining costs have been so reduced as to convert what formerly was waste rock into workable ore. It is now an old story and the wonder of it has already passed, but that it should be possible to mine at a profit rock containing less than one per cent of copper in the form of sulphides, even when metal prices are normal, is none the less a marvellous performance, and one which reflects great credit on all concerned. Yet this has been done for months at a time by the Nevada Consolidated Copper Company, and others have done almost as well. There are now many 'porphyry' mines, not all of which work in porphyry, and not all of which by any means face the same conditions or employ the same methods. It will be convenient to discuss the matter in the light of the experience of the Utah, Chino, and Ray mines which constitute the group over which Mr. D. C. Jackling presides as managing director. By common consent these constitute the principal porphyry group, and Mr. Jackling is quite as distinctly the pioneer engineer deserving of major credit for the development of the type. The size of the undertakings and the low grade of the ore are perhaps sufficiently indicated by the figures below:

	Outstanding Stocks and bonds	Ore reserve. Short tons	Copper per cent.
Utah	$16,270,400	377,690,400	1·453
Ray	17,257,290	74,765,789	2·214
Chino	4,349,700	90,270,155	1·75

The Utah mine is at Bingham Canyon, near Salt Lake City. Some account of the geology of the deposit was given in our Précis last month. Mining there is now exclusively by means of steam-shovels, and the great open pits form one of the sights of America. On the edge of Salt Lake two mammoth concentrating mills have been built, where after dry crushing and screening, wet methods of concentration are employed to obtain a product which is sold to a neighbouring smelter owned by the American Smelters Securities Company. At the Ray mine in Arizona the ore is won entirely by underground methods, but is concentrated and smelted as in Utah. The Chino mine is in New Mexico and the ore is produced mainly by means of steam-shovels from open pits and concentrated as at the other mines, though in 1914 2,093,723 pounds of copper was produced from ore shipped direct to the smelter. The technical work at all these mines has many interesting phases, but the feature which sets them off and marks the type is the scale of operations. What this is, and how it affects costs may be seen from the following figures of performance at the Utah for the year 1914:

Dry tons treated	6,470,166
Mining cost per ton	$0·3232
Milling cost per ton	$0·3536
Transportation cost per ton	$0·2782
Total cost per ton	$0 95
Copper in ore, %	1·4249
Net copper produced, lb	115,690,445
Cost per pound, cents	8·131

Despite the success achieved by these companies, and the satisfactory dividends that have been paid for some years, there has always been a feeling that they were vulnerable under any condition that forced a serious limitation of output. It was thought that they were too large as regards plant and capital to permit them to curtail or to shut down, and that whether or no they must produce through bad as well as good times. This was a natural conclusion from the known facts and one widely held. The past eighteen months put the matter to test, and to general surprise the result was the contrary. It was found that in fact the ouput could be cut 40% without serious increase in cost, and that the properties responded with surprising quickness both to retardation and acceleration. The opening of the war found copper prices good and production in full swing. It upset the whole copper market. The United States, which produces usually 60% of the world's supply, had been selling to Germany and Austria something over one-third of that exported. This market was suddenly cut off, and the price of copper in New York could only be sustained by equally prompt curtailment of production. This meant a reduction of nearly one-half, and was put into effect at the larger properties within a few days. It was three months later that the effect showed in the refinery output, and by that time the munition demand already foreshadowed advancing prices. By the first of the year the tremendous demand that has since been felt was clearly anticipated, and full production was resumed as promptly as possible. The figures below show the fall and rise of production at the three properties in 1914 and 1915, the figures being for gross copper in concentrates at each mine, and stated in pounds:

1914	Utah	Ray	Chino
1st quarter	32,846,155	17,234,346	17,288,678
2nd ,,	40,017,562	18,748,343	17,032,871
3rd ,,	28,686,672	12,475,153	11,491,120
4th ,,	20,229,012	9,563,113	8,935,585
1915			
1st quarter	26,415,995	14,463,213	11,732,508
2nd ,,	40,799,825	14,524,380	18,455,502
3rd ,,	44,766,841	14,931,388	18,545,638

These figures illustrate strikingly the fact that despite their size these operations are extremely flexible. In the following and concluding table it is shown that the reduction in output through the second half of 1914 did not result in the increase in cost that had been so widely anticipated. The figures are in pounds, and cents per pound, and 1913, the last year of normal conditions, is taken as a basis for comparison:

	Production, net		Cost	
	1913	1914	1913	1914
Utah	119,939,809	121,779,401	9·496	8·131
Ray	53,745,937	58,020,955	9·783	8·839
Chino	50,574,661	56,841,977	8·787	7·680

These are most gratifying figures and reflect great credit on the management. It is evident that in these large mines the overhead expense is not only less per ton, but less proportionately per ton than in smaller operations. Reduction in output decreases the direct expense proportional to the degree of curtailment. The increase in overhead for the second part of the year was more than absorbed by the increase in output through the first half of 1914 as compared with 1913. It remains to add that while a long shut down would entail a heavy interest charge, the excellent financial direction of the companies had lead to such accumulation of surplus as to prevent this becoming serious even though the depression extended through a half year or more. Wholesale mining has unsuspected features of strength.

Aluminium.

The demand for aluminium for war purposes, more particularly in connection with the manufacture of aeroplanes and motor-cars, has denuded the market of all free supplies of the metal, and the quotation, after soaring from £80 per ton to over £200, finally disappeared from view altogether. We have no reason for presuming that this absence of price signifies any serious shortage of the metal for the particular purpose for which it is required. These remarks apply of course only to England and her Allies. Germany's requirements are greater, for the Zeppelin fleet calls for enormous quantities. The metal is not produced within the German Empire, though German capital controls smelting works in Switzerland and Austria. Hitherto the ore treated at these works has come from the south of France. Now that the supplies are unobtainable, it is possible that some of the inferior bauxites of Germany and Austria may have been substituted. The probability, however, is that Germany relies chiefly on accumulated stocks of the metal. Another circumstance in connection with the war that attracted attention to aluminium was the temporary difficulty of securing zinc for the Allies, and the high price for the best quality that still rules in America, where the supplies for the Allies have to be bought. As we mentioned in our issue of July last, the study of brasses in which zinc is partly replaced by aluminium has received an impetus for this reason. The relative advantages of copper and aluminium do not enter into the scope of the discussion as to the war supplies of the metals. Nor is there cause for any debate with regard to substitutes for aluminium. The war has certainly had the effect of drawing the attention of manufacturers to the advantages of aluminium, and their chief anxiety is caused by the lack of supplies and the inordinate price. They are accordingly moved to investigate the conditions that rule the market, the factors that decide the current and future output, and the eventual resources of the world in this direction. For this reason an outline of the aluminium industry will be of interest to our readers.

Though aluminium is by far the most widely distributed metal in nature, the fact that its oxide cannot be reduced by carbon at temperatures obtained by the combustion of the latter has stood in the way of its commercial application. The earliest practicable method of extraction was invented in 1855, when the reaction of metallic sodium on a chloride or double chloride of aluminium was employed, and later, cryolite, the double fluoride of sodium and aluminium, was used instead of the artificial chlorides. The Aluminium Company, formed in England in the eighties, developed a process for producing sodium cheaply, and after the abandonment of the manufacture of aluminium by this reaction, the improved method of obtaining sodium was of great value in the electrolytic soda process and in the manufacture of sodium cyanide.

Later, the brothers Cowles experimented on the reaction with carbon on alumina in the electric furnace. They conducted the operation in presence of copper, and so produced an aluminium bronze. Shortly afterward, Hall in America and Heroult in France discovered that the dissociation of alumina by the electric current could be comparatively easily effected when it was dissolved in a bath of cryolite. In this process carbon anodes are used, which are rapidly consumed by the reaction of the oxygen liberated by the current. The patents of Hall and Heroult differed little in detail, but the fight between the holding companies lasted for 15 years before an amicable arrangement as to patent rights and output was made between the various users throughout the world. In connection with this process, two points require special attention. In the first place pure alumina has first of all to be prepared, and secondly a cheap source of electric power must be obtained. With regard to power, it has been found by experience necessary to employ hydro-electric installations, where, though the initial outlay is great, the cost of the power is little more than the cost of maintenance of the plant.

The preparation of pure alumina for the electrolytic process is in no case easy or cheap. Though alumina occurs widely among igneous rocks in felspar, mica, and garnet, and among sedimentary deposits in clays and shales, its invariable association with silica renders its separation difficult. The only practicable ore is bauxite, the hydrated oxide of aluminium containing varying amounts of iron oxide. Lacroix, Fermor, and Mead have all described bauxite as a decomposition product of an igneous rock, produced in the same way as the laterites. It is a soft earthy ore, in appearance similar to limonite, and it usually contains silica and titanic acid. The older method of separating alumina from the ore, still usually employed, consists of first roasting to convert the iron to the ferric state, and then treating under pressure with caustic soda solution. The alumina is dissolved by the soda with the formation of sodium aluminate, an unstable compound that precipitates its alumina when brought into contact with pure aluminium hydroxide. The other method has been developed by Serpek in France and has the additional advantage of fixing atmospheric nitrogen as well as purifying alumina. The bauxite is heated with carbon and exposed to the action of a current of nitrogen. The result of this reaction is the production of aluminium nitride, which on contact with water yields alumina and ammonia. Thus an aluminium factory and a fertilizer works may exist side by side. The attempts to make alumina from common clay have been many. Three years ago Alfred Cowles published an account of a process whereby clay is mixed with common salt and carbon, and moulded into porous briquettes, which are exposed to the action of heat and steam. By this process sodium silico-aluminate and hydrochloric acid are formed, and the former is ground and heated with lime, with the production of silicate of lime and sodium aluminate. The alumina is recovered from the sodium aluminate in the same way as in the bauxite process. We have not heard that Mr. Cowles' method is as yet a commercial success.

In placing any new article on the market, it is necessary to consider its possible applications and its ability to displace other articles the uses and properties of which are established and well known. Recognition of a new article on the part of the public and of manufacturers is usually slow. In the case of aluminium many difficulties had to be overcome in connection with the intrinsic advantages of the article itself. The aluminium produced by the sodium process was not sufficiently pure to give good mechanical results, and aluminium by itself is not sufficiently strong and hard for many purposes for which it is otherwise well adapted. There has been evidence on several occasions of the anxiety of the various producers to expand their business so rapidly as to cause the output to be greater than the demand, and the price has then fallen to the level of unremunerativeness. During the year or two preceding the war, an international agreement provided for the prospective yearly outputs and for such increases in capacity of metallurgical plant as might be reasonably required. Thus the price had been maintained steadily at about

£80 per ton. Such an arrangement obviously does not allow of any large amount of free supplies. During the year 1914, Professor J. W. Richards estimates the production in the United States at 42,270 metric tons, the Aluminium Company of America being the sole producer. This company also has a plant in Canada where 6820 tons was produced. The Aluminium Français Company produced 12,000 tons in France and 1500 tons in Norway, the Aluminium Industrie Aktien Gesellschaft 10,000 tons in Switzerland and 4000 in Austria, the British Aluminium Company 8000 tons in Scotland and 1000 tons in Norway, and the Societa d'Aluminio in Italy 800 tons, making a total world's output of 86,390 tons. This figure is small compared with the million tons each of copper, zinc, and lead, and is rather less than the output of tin. A prospective new producer in America is the Southern Aluminium Company, which was formed to erect a works in North Carolina by the American Metal Co. and the French company. War put a stop to the project, but recently the Aluminium Company of America has secured control and will proceed forthwith with the construction work. The world's supplies of bauxite come from Arkansas and other states in America, from many of the southern departments in France, from County Antrim in Ireland, and from the Abruzzi in Italy. Extensive deposits are known in various parts of Africa, in India, in Australia, and other countries, and the supplies are sufficiently plentiful to postpone the consideration of Cowles' proposed treatment of common clay. In the meantime, however, a new source is suggested by the use of alunite for making potash, with alumina as a by-product.

The possibility of an expansion in the consumption of aluminium cannot be gauged with any accuracy. As a conductor of electricity it is a serious rival to copper, and the choice of one or other, when prejudice does not decide at once in favour of the better known metal, depends almost entirely on the relative prices of the two and the possibility of obtaining early delivery. In construction work where lightness is the prime requisite, aluminium is always in demand, but owing to the softness of the pure metal, it is alloyed with other metals which impart to it the necessary strength. Of these, copper and manganese have been most used, their proportions being from ½ to 4%. Another group of alloys contain small quantities of magnesium, though the advantage is not clear. Zinc, when perfectly pure, added in the proportion of 25%, is said to give a very hard and strong alloy. For domestic utensils and for apparatus employed in many trades connected with varnish, oil, jam, etc., it is admirably adapted. Its leaf is a serious rival to tinfoil. It is employed in iron metallurgy for increasing the homogeneity of castings, and for producing by its combustion an intense heat sufficient to weld together two pieces of iron. Its fierce combustion makes it applicable to the production of explosives, and ammonal contains 25% of it. Recently aluminium has been introduced in the metallurgy of gold and silver for precipitating the precious metal from cyanide solutions. Though the cost of the metal and soda ash required is greater than that of zinc at normal prices, the saving of cyanide resulting from its use substantially decreases the total cost.

In concluding this review, we would say that much valuable information relating to the production of aluminium and the nature of its alloys is to be found readily available to English readers in the reports of the Alloys Research Committee of the Institution of Mechanical Engineers, the transactions of the Institute of Metals, and in the chapters by Professor J. W. Richards published every year in the 'Mineral Industry' from its commencement twenty-three years ago. We greatly miss Professor Richards' book on aluminium, which was published in years gone by. We hope he will give us a new edition, even though the details of metallurgical extraction are not now available owing to the production of the metal being in the hands of a group of close corporations. The only book devoted to aluminium at present extant is a small one by Minet, written in the French language. An English translation by Waldo was published in America, but it appears to be out of print, so that books on aluminium in the English language are scarce just now.

TIN AND TUNGSTEN IN PORTUGAL

By THOMAS A. DOWN.

Tin and tungsten deposits are found in the eastern part of Beira province, Portugal. The author describes the geology and mining possibilities of the state, and gives details of the results obtained by him in drilling alluvial deposits. Government regulations are summarized.

THE possibilities of Portugal as a tin producing country have attracted a considerable amount of attention during the last three or four years. The country people living in the southeastern portion of the province of Beira have recently produced by primitive methods of work considerable quantities of tin concentrate from alluvial deposits. The principal result of the professional prospecting so far carried out by American and English engineers was the erection during the autumn of 1914, by the Portuguese American Tin Company, of a powerful bucket-dredge in the Gaia valley on the upper reaches of the Zezere river, near the town of Belmonte.

THE STANNIFEROUS DISTRICTS. — The region containing alluvial deposits more or less stanniferous is extensive. To my personal knowledge it takes in practically the whole of the area enclosed by a line drawn from a point a few miles north of the Mondego river through the town of Celorico to the city of Covilha, and then by parallel lines from these extremes through Pinhel and Sabugal to the Spanish frontier. In view of the fact that the granite continues uninterruptedly for at least 25 miles north of Celorico it can, I am inclined to think, reasonably be inferred that similar mineralizing agencies will probably be found to have operated for a considerable distance in that direction. There is also the likelihood of patches of tin-bearing alluvium existing to the westward because, according to the Carta Geologica de Portugal, granite of similar constitution continues in an unbroken mass in that direction to within a short distance of the coast. The same parallels in an easterly direction pass the frontier into Spain and embrace the Salamanca tin alluvials, concerning which there was considerable excitement 20 years or so ago. In a southerly direction tin has been found in the alluvium at Medelim, 20 miles southeast from Covilha. In this case the granite region, which is entirely surrounded by the Cambrian schist, is 50 square miles in area.

Only a short time prior to the outbreak of war I examined for alluvial tin, and for the rock occurrence of tin and other minerals, several extensive and widely separated sections of ground within and near a triangle formed by the city of Guarda and the towns of Belmonte and Sabugal. This district, the altitude of which varies from 500 to 1050 metres (1640 to 3450 ft.) is drained on its western and southern sides by streams forming the sources of the Zezere river. The principal stream runs through the broad and flat Gaia valley, at the head of which the river forks into three ravines cutting deeply into the hills. The high ground above attains its maximum height of 1050 metres (3450 ft.) at the city of Guarda. The northeastern side of the triangle sheds its water by means of streams which ultimately reach the Atlantic Ocean through the Douro river.

While in the valleys and shallow ravines the soil is productive, agricultural operations being successfully carried on and fruit in considerable variety being grown, there are extensive unproductive sections where the bare bedrock, often very friable, is continually exposed to the disintegrating atmospheric influences of long, dry, and very hot summers followed by cold boisterous winters and torrential rains.

THE SOURCE OF THE TIN.—The preceding remarks have outlined an extensive region, embracing alluvial deposits containing cassiterite, but whether, taking into consideration quality, area, depth, situation, available water, and surface ownership, any of them may be worked with profit is, of course, another question. The tin oxide is found not only in some of the principal valleys, but also in many of the numerous ravines with which the highlands are furrowed. These ravines carry considerable streams of water during the period of winter rains, but in the early summer, in most cases, they become dry and remain so for several months.

The original source of the tin can probably be attributed to an extremely thin dissemination through extensive sections, if not of the entire granitic mass. Occasionally, however, beds of pegmatite, more or less uniform in structure and comparatively speaking rich in tin are met with, varying, as regards position, from the horizontal to a considerable dip.

RESULTS OF BORING ALLUVIAL TIN GROUND IN GAIA VALLEY.

TABLE I.

	Depth of Holes	Yield of Concentrate	Assay Values %		Residue
	ft. in.	lb. per cu. yd.	Sn	Sn O_2	
Line A	20 2	9·8	27·60	35·12	Principally Ti O_2
,, B	19 2	8·5	33·70	42·76	,, ,,
Combined Average...	19 8	9·15	30·65	38·94	,, ,,

TABLE II.

	Depth of Holes	Yield of Concentrate	Assay Values %		Residue
	ft. in.	lb. per cu. yd.	Sn	Sn O_2	
Line C.	15 7	4·01	9·10	11·54	Principally Ti O_2
,, D.	11 10	2·49			
,, E.	13 0	2·45	6·30	8·00	,, ,,
,, F.	14 2	1·77			

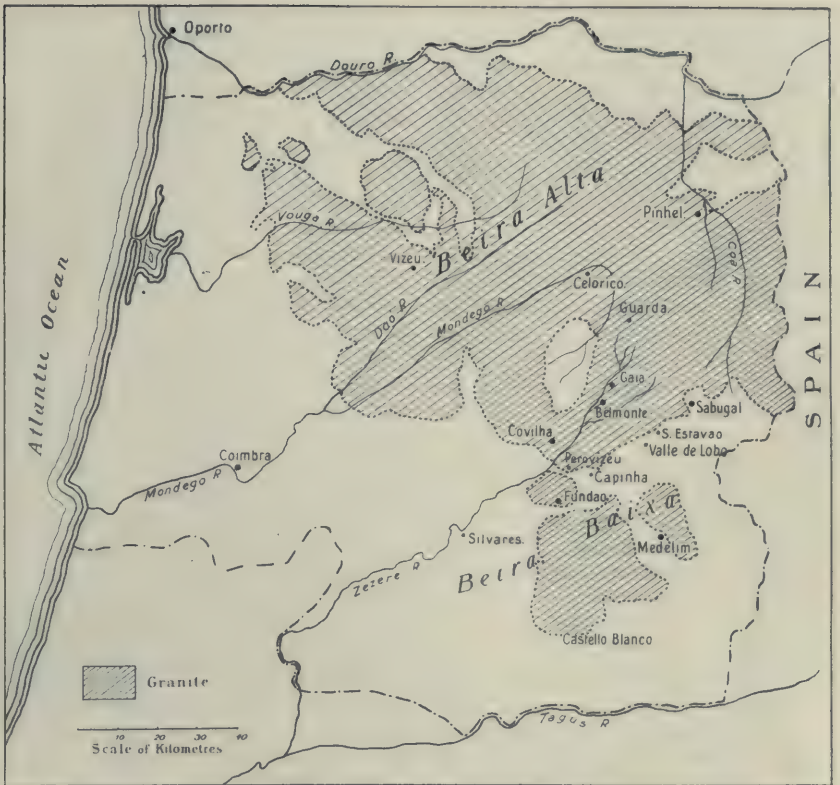
Whether the bulk of the cassiterite came from the general rock mass, or from the pegmatite beds in particular, there can be little doubt that, with certain probable exceptions where there are indications of glacial origin, the existing concentration is due to erosion and aqueous deposition.

With two exceptions I did not find the deposits to be of any considerable importance. Small fairly rich pockets were occasionally found, but in the majority of cases the samples taken yielded very low assays, and the clean concentrate contained a considerable percentage of titanic oxide. The exceptions referred to are situated in the Gaia and Colmeal valleys, the latter a branch of the Gaia, joining at Belmonte, that of the Gaia valley being by far the most important, because the physical conditions, that is, the area, depth of alluvium, even nature of the bedrock and a sufficiency of water makes it an ideal dredging proposition; whereas in the case of the Colmeal valley the conditions are unsuitable for operating with even a very small bucket-dredge.

Owing to the decomposed condition of the rock, erosion has caused an enormous displacement of material of a sandy nature along three lengthy and deep ravines discharging into the river at the head of the Gaia valley. It is a striking example of sluicing on a gigantic scale. Only natural agencies could work so patiently and so economically. The result in the valley is the deposition, so far as present knowledge goes, of by far the most important alluvial tin area in Portugal.

SAMPLING OPERATIONS.—Owing to the limited time and means at disposal I was obliged to confine the operations to sections where I considered the conditions to be representative. Proceeding in this manner I was enabled by means of data obtained from 610 one-metre-square test pits, whose average depth was 1·2 metres, and 153 Banka hand-drill tests, averaging 10 ft. deep, to prepare my report by a fixed date. The report covered 53 claims (registros) made up of several widely separated groups, taking in the large area of country already described. The combined area of the claims was 53 square kilometres, or 13,250 acres. Not more than a third part of this acreage could, however, be seriously regarded as suitable, physically, for any method whatever of placer mining.

The tube of the Banka drill employed was of 4 in. internal diameter, and the maximum depth drilled in a single test was 25 ft. to bedrock. Occasionally the sample taken from a drill-hole was checked by a sample from a pit sunk alongside, and vice versa, with closely similar results. My experience is that when carefully managed, reliable and cheaply obtained data can be obtained with regard to alluvial deposits, where the depth does not exceed 30 ft., by means of the 4-in. Banka hand prospecting drill. Care should always be taken to continue the drilling for a time after the colour indicates that the bedrock has been touched, otherwise there is a danger of



Map of Beira Province, Portugal, showing Granite country.

some portion of the mineral content of the core being driven into and left behind in the more or less decomposed upper portion of the bedrock. Another point of vital importance is that the tube should always be kept in its proper position relative to that of the cutting tool and the ball valve pump, to prevent a portion of the valuable part of the core being driven horizontally outside the circle of the tube and lost to the sample, or, on the contrary, of obtaining a core sample in excess of the diameter of the tube. As to what is the proper position for the tube must, of course, depend upon the nature of the deposit being drilled. Obviously, when going through soft mud, or through sand which is not well settled, the tube should be kept well ahead of the pump. On the other hand, it is sometimes, owing to the compact hard nature of the substance being sampled, difficult or impossible to drive the tube until way has been made for it by the chisel. It is a matter to be decided by the responsible operator according to circumstances, but the reliability or otherwise of the sampling will be largely influenced by whether this feature of the operation is given the constant intelligent attention it demands.

Results of Drilling in Gaia Valley.—My investigations in this valley were confined to that portion extending down the stream three kilometres from the village of Gaia. The alluvium was sampled by drill-holes along six lines A, B, C, D, E, and F, in order down stream, across the flat valley. The results along the lines A and B are given in Table I. The difference in the results obtained from the drill cores as the operations were carried further down the valley became very marked, as the following data for boring along lines C, D, E, and F in Table II. will indicate. These figures prove that not only did the samples show a great decrease in the quantity of concentrate, but also that in its tin content it became so low-grade as to pass out of the sphere of practical importance.

The portion of the valley suitable for bucket-dredging operations, from the point of view of its physical features, extends for at least four kilometres up the river from the village of Gaia, and considering the greater granularity and specific gravity of the cassiterite, as compared with the titanic oxide, it may reasonably be assumed that it constitutes the more valuable section of the deposit. I did not have an opportunity to see the data obtained from the sampling of this ground, but there is tangible evidence of its satisfactory nature in the fact that the people concerned have already been operating there considerably over a year with a large capacity bucket-dredge.

The results obtained from drill-sampling in three other valleys in the district, where the alluvium physically speaking is suitable for bucket-dredging, were not, owing to the low grade and the preponderant proportion of the TiO_2 constituent in the concentrate, such as to cause them to be regarded as desirable properties.

TIN PRODUCTION.—All minerals in Portugal are primarily owned by the State, and cannot be legally worked except under definite titles granted by the Government. This law is applied rigidly to registered companies, and all foreign companies working in Portugal have to register; but it has been largely evaded by the peasants who, working the light alluvials by means of pick, shovel and pan under the simple permission of, and often in partnership with, the owners of the land, were responsible for the bulk of the tin produced in the province of Beira down to the middle of the year 1914. Since then the greatly increased output has been accounted for by the dredging operations of the Portuguese American Tin Co. in the Gaia valley. Their monthly recovery is from 35 to 40 tons of concentrate.

I made an experiment by hand sluicing in the Colmeal valley during the early part of the year 1913, and produced 8 tons of concentrate averaging 48% metallic tin. The remaining constituent was principally titanic oxide. A considerable portion of the cassiterite consisted of fairly large water-worn crystals, while the titaniferous material was mostly in a finely broken condition. By a simple screening process, employing a fairly fine mesh, a rough separation was effected resulting in 5 tons of first quality product containing 65% Sn, while the other portion (3 tons) which passed the screen assayed only 19% metallic tin. This was held back for further treatment when conditions should justifiy the erection of the necessary plant. The country agents for the firms in Lisbon and Oporto who buy the tin from the peasants employ the same screening method when purchasing, and they only accept the first quality.

With regard to the light alluvial deposits situated in the ravines and depressions of the highlands, small but rich pockets are occasionally found where a natural rock basin has facilitated deposition. The peasants know well where to look for these rich spots, and I found at many such places that the alluvium had been turned over and the rich streak, usually found resting on the bedrock, already extracted. Generally speaking, the concentrate contained in these minor deposits is less titaniferous than is the case with the more extensive deposits in the big valleys. Owing, however, to their limited extent and the manner in which they are widely scattered, taking the region I examined as a fair sample, it is extremely unlikely that the conditions are such as could be successfully handled by organized syndicates or companies. Topographically the country is unsuitable to dam construction, except at enormous cost, and to work the ground by hydraulic methods would therefore necessitate pumping and carrying water by pipe-lines for great distances. Then, too, the matter of arranging with the landowners would be an enormously difficult and expensive business. The surface is all privately owned, and a considerable portion of it has been under cultivation from time immemorial. The peasant and the owner in combination do very well, working with simple appliances without taking up or purchasing costly mining rights or paying heavy land damages. They have no administration charges, and they can pick the rich patches in the deposits, the depth of which varies from a few centimetres to 1½ metres.

The possible source of any important increase in the production of alluvial tin in this part of Portugal must be looked for in the extensive valleys where the conditions are such that operations can be conducted on a large scale, and economically, by mechanical methods. Valleys within the regions indicated, when the physical and geological conditions are similar to those of the Gaia valley and its affluents, may reasonably be regarded as worthy of attention.

MINING RIGHTS.—The following remarks briefly describe the procedure for obtaining from the Government the right to mine for and to dispose of minerals. It is divided into three distinct stages, namely, the Registro, Concessão and Demarcação. The fee for the Registro is Reis 13,000 (say £2 10s.), which conveys the right to prospect for one year over an area of country comprised within a fixed circle whose radius is 560 metres. The position of the centre of the Registro (ponto partida) is confirmed by a reference point (ponto referencia) such as the corner of a building or some other mark of a permanent nature. The distance and the magnetic angle to the reference point must be clearly recorded at the time of registration, so also must be stated clearly the names of the owners of the land by which the Registro is confronted on the cardinal points. The next step is to apply for the Concessão, which must be done within 12 months from the date of registration, and the application must be accompanied with a payment of Reis 120,000 (say £24). If the mining authorities are satisfied that the Government regulations have been complied with, the Concessão is granted in due course, and the same is notified in the Diario do Governo. The Concessão is equivalent to a provisional title, giving the right to mine for, but not to dispose of, the products. The latter can only be done after having obtained the definite documentary title, the alvara, which follows the third stage in the proceedings, that is, the demarcation of the property.

Following the granting of the concessão, the Government engineer surveys the ground, taking the notes necessary for the production, at the Government Mining Office in Lisbon, of a complete plan of the Registro, including the positions of mineral deposits and veins. On this plan the demarcation is made. The grant in its final form is that of a parallelogram whose measurement is 1000 by 500 metres, exactly half of a square kilometre, and is, therefore, equal to only half the area of the circle originally registered.

When registering, great care must be taken to state explicitly what minerals are to be prospected for and the manner of their occurrence, whether in rock or alluvium. A case came to my knowledge where the ground was registered for "uranium and other minerals." A so-called uranium vein proved to be worthless, but alluvium of considerable value for tin was found in another part of the same claim. The parties interested were confident that the terms employed in their registration embraced the tin in the alluvial deposit. Unfortunately however, for them, the interpretation given in the Ministry of Mines was that the words "and other minerals" would have applied to minerals which might have occurred in the same vein with the uranium, but did not apply to the alluvial tin, situated in another portion of the area over which the right to prospect had been granted. The sequel was that the Government engineer allocated the alluvial deposit to another party, who, at a much later date, definitely registered for alluvial tin over the same ground.

The mining laws provide for the lapse of the Registro if the Concessão is not applied for within one year from the date of registration. This regulation is, however, continually evaded by the same owner re-registering in another name.

The time likely to elapse from the act of registration to the granting of the definite title, the alvara, may vary from a few months to two or three years, according to the congested condition, or otherwise, of the work at the head mining office. Much will, however, depend upon what influeuce can be brought to bear.

Foreigners who may be inclined to purchase mining properties in Portugal should, without fail, before taking any definite step, obtain full particulars as to titles from the Government Department of Mines in Lisbon, where they will find their requests readily complied with.

These remarks are based on the mining laws as they stood two years ago. It was then rumoured that the Government, with a view to simplification, contemplated amending the code. Such matters, however, move slowly in Portugal.

TIN LODES.—As regards the occurrence of tin lodes in Portugal, I will confine my remarks to the Guarda-Belmonte-Sabugal region. I believe, however, in this respect that the region is also representative of a much more extensive area. There has not yet been made a discovery of sufficient importance to indicate the likelihood of the establishment of a lode-tin mining industry. Small irregular quartzose veins fairly rich in tin have been worked here and there, but they have soon been found wanting in persistency.

The pegmatite beds, fairly numerous in some districts, may be said to offer possibilities, but from a series of vanning tests the maximum result obtained was at the rate of only a few pounds of SnO_2 per ton. The sample in this case was taken, in a shaft, over 1·2 metre in thickness of pegmatite at 5 metres from the surface down an angle of dip of 40°. The outcrop of the bed, always carrying tin oxide in very small quantities, was definitely traced for 200 metres.

TUNGSTEN.—The bulk of the output of tungsten from Portugal is produced as wolfram at two mines, namely, the Burralha mine in the Province of Tres-Os-Montes, and the Panasqueira mine at Silvares, 13 miles south-west from the city of Covilhã. The yield from both mines has been important for many years, that of Panasqueira for the year ended September 30, 1914, being 235 tons of wolfram. These properties are owned and operated by foreign companies, French and English respectively. The Portuguese people, attracted by the demand for wolfram, have during the last three or four years, in certain districts of the province of Beira, registered a large number of mining claims, and the peasants working along the outcrops of the veins, sometimes with, but often without the claim-owner's permission, have in many instances produced appreciable quantities of the ore. These remarks apply especially to a belt of country indicated by a line drawn to connect the old-world but important towns of Fundão and Sabugal, and embracing the less important towns of Perovizeu, Capinha, Salgueiro, Valle do Lobo, and Sto. Estavão, all situated in the neighbourhood of the granite and Cambrian schist contact.

During a few days spent in this district I examined numerous claims upon which the owners had done a considerable amount of prospecting. The greater part of the veins exposed were of no importance, but in a few cases I was favourably impressed by well formed veins composed of congenial white quartz, traceable by their outcrops for long distances. That they were wolfram-bearing veins was demonstrated at several points where I saw excellent specimens being extracted from shallow workings. This is undoubtedly a wolfram zone of promise, and should attract the attention, especially under present conditions, of capitalists interested in the production of the ore. It is really an extension in a northeasterly direction of the geological conditions among which the productive Panasqueira wolfram mine is situated.

Another district in which the occurrence of wolfram has been demonstrated is that of Vizeu. At São Cosmado, a few miles from the city of Vizeu, trial mining over an extensive area has been done by a Portuguese firm of Oporto on several wolfram-bearing quartz veins and beds in the granite. When I last visited the locality, two years ago, the workings had not then, in any instance, reached that stage where it could be said that the persistence in depth of the vein was fully confirmed, but in a few cases the features revealed were such as to make it seem highly probable that the orebodies would hold down. Still another district in which wolframite veins have been located is that of Pinhel in an easterly direction 75 kilometres from Vizeu. Situated along the contact of the granite and Cambrian schist, the geological conditions here are similar to those on the Fundão-Sabugal line. It will be understood from what has been stated that the existence of wolfram-bearing deposits has been proved in various widely separated districts in Portugal. When this is considered in conjunction with the geological conditions, it will be seen that the country offers inducements to those who may be interested in discovering sources of tungsten.

Mine Labour in the United Kingdom.

Owing to the war and the depleted staffs, the figures for labour and accidents in mines in the United Kingdom for 1914 have only just been published. For the purposes of comparison as regards numbers employed the figures are confined to the first seven months of the year. The total employed at mines was 1,157,455, and at quarries 78,908. Of those employed at mines, 1,157,455 worked underground and 227,648 above ground. As compared with 1913, the figures show an increase of 3448 working underground and a decrease of 1295 above ground. The figures for employment at quarries show a decrease of 2001 as compared with the previous year. The number of mines registered under the Coal Mines Act was 2988, and under the Metalliferous Mines Act 564, and the number of quarries registered under the Quarries Act 7239, a total of 10,791.

During the year 1914, the total number of fatal accidents at mines and quarries was 1300, involving the loss of 1338 lives, a decrease of 32 in the total number of accidents and a decrease of 532 in the number of lives lost, as compared with the previous year. Of the total number, 1182 occurred in mines registered under the Coal Mines Act, 23 in mines registered under the Metalliferous Mines Act, and 96 in quarries. The coal mines were unusally free from explosions, for only 26 deaths were caused by 10 explosions, figures comparing with an average during the preceding five years of 270 deaths from 18·6 explosions. Other fatal accidents were: 585 due to falls of ground, killing 596; shaft accidents 63, killing 66; surface accidents 132, killing 133; other accidents, numbering 392, caused the death of 398 men. In the metalliferous mines, 7 accidents from fall of ground killed 8 men, 3 shaft accidents killed 3 men, and 6 surface accidents killed 6, the remaining 7 being grouped under miscellaneous.

AN ENGINEER'S IMPRESSIONS OF RUSSIA

By EDWARD T. McCARTHY.

A mining engineer's notes of travel through Russia during war time; his impression of the spirit of the people, with accounts of the tribulations of the Polish and Galician refugees, and of the camps in Siberia for German and Austrian prisoners of war.

TOWARD the end of August I left England on an inspection visit to the Spassky and Atbasar copper mines in Central Siberia. As the usual route by Berlin was closed it was necessary to cross the North Sea to Bergen, thence to Christiania, and on to Stockholm. From there the route takes you to the north of Sweden, and across the boundary line into Finland at Tornea, which is about 30 miles south of the Arctic circle. Passing thence through Finland to Petrograd, the journey from England is completed in seven days. At Tornea I saw the first evidences of the war, as there I met a large contingent of the wounded German prisoners of war who, being past any further military duties, were being returned through Sweden to Germany. The Red Cross train in which they arrived was excellently fitted and well officered with orderlies and nurses, and evidently everything possible was being done for them.

In Petrograd the number of wounded appeared to be great, but not until I arrived in Moscow later did I fully realize the enormous number of wounded men. It seemed to me that in Petrograd they were trying to hide the evidences of war as much as possible, as the contrast between the two cities was so great. In Petrograd, again, one's environment seemed to be that of pessimism; in Moscow quite the contrary. In the former, everything was on the surface gay and going on much as usual, but underneath there was a deep dread of the Germans, and that ultimately the Germans would be in Petrograd. At the time it looked very much as if Riga must fall, but now for over three months the Russians have been able to hold the Germans, and have even pushed them back from their most advanced lines of attack, so that it looks, from the present point of view, as if Riga has been saved. In Moscow an appalling sight confronted the traveller. The number of hospitals was something enormous, for almost every large block of buildings had been converted to this use.

At the time I arrived the refugees, old men, women, and children, from Poland and Galicia were pouring in, not by hundreds but by thousands, one of the saddest sights you can conceive. At the five large railway stations crowds were continually arriving, while upon every available space on the platforms, in the stations, and outside on the porticoes these people had taken up their residence. Along the line for miles on the sidings were freight cars crammed with these people, 40 people on an average being in a car. Most of them stood up in the clothes they happened to be wearing when they fled. Some had bundles, but the majority were without any at all. A large number wore their summer clothes, and as it was already getting cold their sufferings can be easily imagined. None or these people had anything given them to eat but a loaf of rye bread. The first hot meal they had had for weeks, in some cases months, was supplied by the English community, who organized travelling soup kitchens which were sent round to the five railway stations. I was at one of the stations when a soup kitchen arrived for the first time. It was difficult to make the people understand that by going out into the street they could get a litre of good hot soup and an extra loaf of bread. They could scarcely believe in such kindness, as apparently they had experienced nothing of the sort except in a few isolated cases of charity. As far as I could ascertain, where Russian charity had provided them with more than their share of rye bread, it had been in the form of cold sausages. The English community's charity in this respect was more of an object lesson as to how to organize relief than in the amount they dispensed. The Russians themselves are a sympathetic people, but are not good at organization when left to initiate it themselves. Hence there was nothing being done for these refugees in the way of giving them hot food.

The Russian Central Moscow Committee was nevertheless working hard to do what they could, but after all it was but little that could be done. Their efforts mainly consisted of seeking quarters or shelter of some sort for these people, and the contribution of bread and cold sausage. The poor women and children, without their husbands or fathers, and the old men, were all pathetically patient. No complaints were to be heard, but on their sad faces suffering was to be seen. So many of the mothers had lost their children, and there were multitudes of children without mother or other protector. In one morning alone they collected, when I was there, 1000 babies from small girls who were mothering them.

Their stories of woe and how they had been treated could only be dragged out of them. They seemed apathetic and to have lost their vitality. It is difficult to describe a throng of this kind, but when you see it for yourself it brings forcibly before you all the horrors of war, even more than seeing the maimed and wounded soldiers. Some of their stories were too horrible even to write about, and from what we could ascertain their stories agreed if the districts they came from were traced. In some cases, apparently, the commander of the German troops had held his men in check and simply driven the people away, or the people had fled on their own account. In others, the commanders must have been fiends, as they had allowed both men and officers to go on a drunken orgy. So that you can picture to yourself what awful horrors the refugees experienced.

Later, on the Siberian line I met these people still travelling in freight cars, all bunched together to keep each other warm, and they were gradually being distributed to the villages throughout Siberia. On my return, having crossed the country from Omsk to Tashkent in Central Asia, about three months later, I saw the same freight trains of human beings passing at the rate of eight a day with 40 carriages to a train. At each station 3 or 4 corpses were being removed per day. As the severe winter had already begun, I do not know how the people managed to exist, but the Russians are a hardy race. Our own peasant class would soon die under such hardships. Although the majority of the refugees were peasants, among them was a good sprinkling of other classes of people.

On my way out to Omsk I visited one of the large prison camps at Tumen, and afterward two more at Omsk. Each camp contains ten thousand prisoners of war. At Tumen the Commandant-in-Charge is a man of the name of Riabzoff, who up to the outbreak of war had been one of the principal Russian employees at Spassky. He it was who obtained permission for me to visit and make a thorough inspection of the camp. The prisoners are in a large fenced-in compound, containing a row of 20 large huts each accommodating 500 men. Each hut is supplied with a large Russian stove, and kept thereby well warmed. In their stores they had supplies of overcoats lined with cotton-wool for each man, together with a scarf which I should call a shawl, besides large stocks of well-made boots, socks, and underlinen. Their bakeries were producing as good a bread as you would find in any first-class hotel. The camp too was supplied with hot water, which is more than can be said of our soldiers' camps at home. Their food I consider was not merely nutritious but excellent in quality. In addition they have large Russian baths which are built on the lines of a Turkish bath, the hot rooms being vapoury instead of at a dry heat.

The Austrians were allowed to go into the towns and villages to work, receiving one shilling in cash, and one shilling credited to them, which they will get at the end of the war if the Germans are proved to be treating their prisoners better than in the past. Until recently they only received 5d. in cash and 7d. on credit at the stores to buy extras. The German prisoners were formerly allowed to go out to work, but were brought back again as they behaved so badly. I told Riabzoff that I thought the Russian sympathy toward the Austrians and their hatred of the Germans had made the difference, but Riabzoff assured me on his word of honour that, after making the fullest investigations, he found that the Germans behaved to the unprotected women folk in the villages in the most atrocious way, while save in sporadic cases, this did not happen with the Austrians. At Omsk the prison camps were a copy of that at Tumen.

From Omsk I went up the Irtish river two days, and called at Ekibastus, where they are erecting big zinc-smelting works. From there I went to Spassky to find things less upset by the mobilization than I expected, but still upset by it, and from there to the Atbasar mines. On the way we were caught in the first boran (blizzard) of the season and we had a narrow escape, as we had lost our way and had no house within 100 miles of us. Fortunately we struck a Khirgese winter-quarter hut, made of mud. In this we escaped from the storm, along with a crowd of Khirgese who, travelling in the district and seeing the storm approaching, had also made tracks for it. So we were all huddled together for the night, and a very unpleasant one it was. Next morning about 11 o'clock, the storm having abated, we started afresh, and at about 30 miles out ran into a snow drift and down went our car into a hole. After vain attempts to dig it out and the drivers having decided to abandon it, they made one final effort at my persuasion, and by good luck we just succeeded in recovering it.

The journey from Spassky to Atbasar, which in summer time can be done in 2½ days, took us 6 days, so you may imagine we had a hard trip over the distance of 670 miles.

At Atbasar some of our young men wanted to be allowed to come home to join the army, which I was enabled to arrange. From Atbasar we made for the Tashkent line of railway about 250 miles distant, and after a short visit to Tashkent itself, I left for Moscow, meeting, as already recorded, the refugee trains en route.

At Moscow I found that they had about 800,000 refugees under shelter, though many were still sleeping in the open, notwithstanding the cold. Over 50% of the wounded are commonly reported as being in Moscow. The city is one huge hospital. One thing above all others that the Russians have done is to effect a magnificent organization of the Red Cross. Russia is full of anomalies. The Red Cross organization is an apparent contradiction to everything else in Russia. In Government circles there seems to be no correlation between one department and another, yet there they are carrying on the feeding and equipment of a stupendous army, and in the midst of all actively mobilizing another army from a list of 6 million of men, begun in October and to be finished by January 13, the end of the Russian year. These men they intend to train for five months. Shell-ammunition is coming in well now, and there appears to be no fear in this respect for the future; the only fears are of German influences at work endeavouring to disorganize wherever they can make their subtle influence felt. The trouble with Russia is that, as she has so many thousands upon thousands of subjects of German extraction, it is almost impossible to deal with this element.

The spirit of the country is grand. The soldiers are magnificent. In the earlier periods of the war, for want of bayonets and rifles, they often fought in the trenches with sticks only. What other soldiers in the world could they get to do this, unless at least supported by hand grenades? The feeling in the country is that if every man has to be sacrificed they will do it. The only centre where there is a feeling of pessimism is Petrograd itself, where reactionary German influences are great, but the whole nation outside Petrograd, as far as I can define, is one. The German methods of frightfulness have united the nation, I believe, and in no other way could it have been done. All these stories which the wounded and refugees are bringing home have permeated through every village in the country into the depths of Siberia, and when you ask any villagers if they would like peace they say, never, so long as the Germans are likely to attack them again.

On my way home I passed through Sweden and Norway, and found those of the Swedes I met openly pro-German, while similarly the Norwegians were pro-English. But all expressed their opinion that Germany would ultimately win, as they say Germany utilizes the best brains of the country, while England muddles by her admixture of incapables with those who might be capable if left to themselves. In conversation, they admit we have brains, but our form of Government does not permit of their best use.

I have forgotten to mention one thing, and that is perhaps the most marvellous of the whole. Russia I always used to put as the most drunken nation in the world, owing to the cheapness of their vodka probably, with our nation a good second, but today it is the most sober one, and as a whole is a nation without drink of any kind. In the fashionable hotels, by squaring the head porter you may be able to get some brought to your bedroom, and in the clubs and among some of the rich there are still stocks in their wine cellars. But nowhere can you openly buy a drink. The people say: if we drank our soldiers would drink, and drunken soldiers could not beat the Germans. This alone will give you some idea of the magnificent spirit that is pervading the country. Wherever I went I found no traces of anyone drinking, and as I travelled away from the railways, 2200 miles, I saw something of the interior of the country, and everywhere it was the same. In the villages hundreds of miles from the seat of war, you will see the peasant women all working for the war.

In conclusion I am sure that in the country taken as a whole there is only one spirit inspiring the nation, namely, to beat Germany at all costs. The only feeling of nervousness is lest Petrograd should succumb to Germany's influence and among the educated classes, I may say, of German influences in high quarters in England.

Mr. H. C. Woolmer, who accompanied me on my journey, is Chairman of the British War Relief Fund, Moscow, and is working hard in this service.

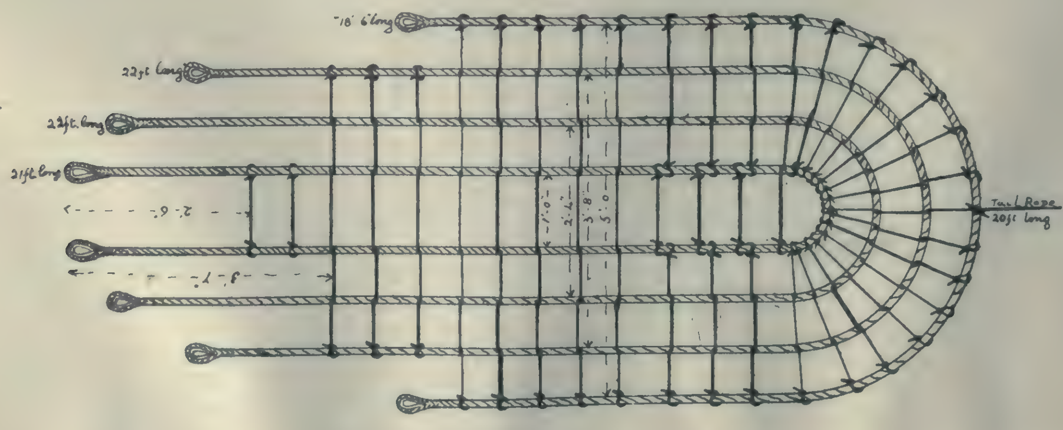
The Net shown in position, Thrown over the Horse's Back.

LOWERING HORSES THROUGH SMALL SHAFTS

By M. T. TAYLOR.

IT has long been recognized that the use of horses for underground traction is one of the cheapest and most flexible methods that can be adopted for conveying broken ore from the various stopes to the shaft bins, but considerable difficulty is often experienced, owing to the small dimensions of the mine shafts, in transporting them from the surface to the underground levels.

A method that I have used at various times with most satisfactory results is described as follows: A net, the dimensions of which are given below, and suitable for lowering horses from 14 to 15 hands high, is thrown over the horse's back, the loop ends toward the head, and the running rope is passed through the loops. These being drawn taut, the bottom ropes are brought tight around the ani-



Details of Construction of the Net.

THE HORSE BEING DRAWN TOWARD THE MOUTH OF THE SHAFT.

mal's hocks and he is forced into a sitting position. If the animal is quiet no further tackle is needed, except to strap his four legs together and secure his head to the main haulage rope. If the animal is fractious, his knees should be padded with bagging, and after the net is placed over him, he should be thrown. To do this, first strap up one of the front legs, and by placing a strap or rope round the fetlock of the other, and then carrying the other end over the horse's wither, at the same time keeping a strain on the rope, endeavour to get the horse to step forward. By this means you will pull up the other leg, and the horse immediately falls to his knees. From this position he can easily be thrown on his side. Strap the four legs together and also secure the head to the main haulage rope. When this is completed the horse is ready to be hauled over the shaft. It is wise temporarily to cover the shaft at the surface until the initial operations are completed. Planking should also be placed slantways against the back of the shaft at the landing plat underground, so that the horse will slide clear out on to the level. Where iron plat-sheets are used, these should be covered; otherwise the horse's hoofs should be bound up in bagging to prevent him slipping when endeavouring to regain his feet when released. My first illustration shows a horse 14–2 hands high ready to be thrown; above, the animal being drawn toward the shaft; opposite, the horse is shown hanging over a 4 ft. by 2 ft. 6 in. shaft, ready to be lowered.

THE HORSE SUSPENDED OVER THE SHAFT, READY TO BE LOWERED.

THE VAAL RIVER DIGGINGS IN GRIQUALAND WEST

By CHARLES W. BOISE

The gravels of the Vaal river and in the ancient beds of the river were worked before the diamond pipes were discovered. Conditions are such that operations on a large scale with expensive plant are not profitable.

During a tour through the alluvial diamond district on the Vaal river in Griqualand West, I visited the principal diggings from Barkly West, through Waldeck's Plant, Keiskama, Niekerk's Rush, and Sydney, to the Droogeveldt areas on the Sydney Estate, the latter of which is credited with being the present leader in diamond production among the various Vaal river diggings.

We may well begin our discussion of this district with a few remarks concerning the topography, with a view to showing the exceptional opportunity there has been during the history of the Vaal river in this area for the deposition of extensive gravel deposits. The great prairie land of this part of South Africa is a plateau of even elevations. The river valleys are as yet comparatively shallow and very broad. These general features are well marked in the area traversed in travelling the road from Kimberley to the bridge across the Vaal, just above Barkly West, and thence down the river to Sydney. Beginning at Kimberley, which is about twelve miles distant by road from the nearest point on the river, and having an elevation only about 500 ft. greater, the travel goes down the almost continuous and scarcely perceptible slopes to the river level. Where it is first seen a few miles above the Barkly West bridge, it is a broad stream meandering through the level floor of a channel from which the valley rises by very gentle slopes. At the Barkly West bridge the definition of the channel itself is somewhat more abrupt, a condition which seems to continue down stream to the crossing at Waldeck's Plant, where the channel again broadens and is bordered by gentle slopes.

With this understanding of the general nature of the Vaal river valley, it is easy to understand how, given the proper deflecting influences in the shape of ancient drainage systems and a bed formed of a series of rocks of uneven bedding and varying hardness, its history can well have been of an unsettled and migratory nature, and abundant opportunity provided for the deposition of terrace gravels over large areas. And indeed, in a comparatively limited area, gravel deposits can be seen which range from the wash in the present bed of the river, through recent terraces closely associated therewith, to inland 'high level' gravels which, in the case of the Droogeveldt areas, are at a distance of over six miles from the present channel and at an elevation of from 300 to 400 ft. above it.

It may be well to emphasize the fact that all the exploitation at present being carried on in the area visited is by individuals or small leasing companies holding the mining rights from the owners of the ground over limited areas, and working, in all cases, with simple and inexpensive equipment. Work by large companies and employing an expensive equipment has been attempted, but it has been found by experience that the present system is the most economical and satisfactory. The most recent attempt to work on a large scale was by the New Vaal River Diamond & Exploration Co., Limited, which owns the area covered by the extensive Droogeveldt diggings, discovered in 1907. The company erected a number of large treatment plants and carried on work for some time, but it was later abandoned for the leasing system. In this area, the Sydney Estate, there are about 400 leases, on which were employed before the war 800 whites and 3500 natives. In Griqualand West the alluvial claim is 60 by 30 ft., and the monthly tax or licence permitting to mine for, as well as to sell, diamonds, is five shillings. On privately owned land the royalty charged is usually 10% of the production.

The mining methods vary with the type of deposit. At the time of my visit all work was confined to deposits outside of the stream channel. In work recently carried on in the channel near Sydney two large breakwaters, or dams, were built across the river from material excavated in digging an artificial channel along one side of the valley which, on completion of the breakwaters, carried the river. The water in the pond thus formed between the two dams was pumped out and the gravel found in the channel worked for diamonds. This type of work can be carried on only in the dry season when the river is at its lowest level, and in the case instanced the breakwaters were lost through an unexpected rush of flood water before time had permitted the complete working of the gravel exposed. It is understood, however, that the work was successful from a financial point of view, and it seems likely that other projects of this nature will be attempted.

In working the terrace gravels the material is excavated in open-cuts, except for a few instances where the deposits were deep and the pay-gravel was found only in a narrow layer at the bottom of the deposit. The amount of overburden varies within wide limits, though in general it does not exceed the depth of the gravel. The overburden can thus, as a rule, be disposed of in exhausted ground. Small boulders found in the gravel are disposed of in the same way, while with large boulders too heavy to move, the gravel from around, and, as much as possible under them, is removed with especial care, as it has been found that such gravel is high in diamonds. Pockets and depressions in the bed-rock are, for the same reason, cleaned with particular care. The gravel is, in general, not cemented, and excavation with pick and shovel offers no difficulties.

The removal of the gravel from the pit depends on conditions. In deep ground, where shaft work is not employed, small derricks, operated by hand-power and carrying a bucket of small capacity, are sometimes used. In other cases, under similar conditions, but where this method would be too slow, the gravel is loaded into mine trucks of 16 cubic feet capacity, which are drawn up an inclined track leading to the washing plant by cable. In shallow ground the gravel is usually shovelled to the surface and taken to the plant in wheelbarrows or cars, depending on the scale of operations, as well as on the financial strength of the proprietor. Owing to the arid nature of the region no difficulty with water is encountered in the excavation of deposits above the river level.

The treatment process varies in different plants, but more with the resources of the owner than with an essential difference in the nature of the material to be treated.

The water supply for the washing operations is usually pumped from the river, this factor involving considerable expense in the exploitation of the 'high level' gravels at a considerable distance inland.

The question of the diamond content of the various deposits in this district is one that cannot be answered in a satisfactory manner. The individual workers keep no records as a rule, but continue working at a certain place as long as it pays, after which it is abandoned and a new place tried. More accurate records were kept during the work carried on by the Vaal River Diamond and Exploration Company, at Sydney, and it was found that the gravel treated ran about 1½ to 2 carats per 100 loads passing through the plants. If we assume that 60% of the ground was so treated, and that the load at 16 cubic feet of loose material represents about one-half of a cubic yard in place we can calculate that the ground in place carried only about one carat in diamonds per 40 cubic yards. Even though the production may have been worth as high as 120 shillings per carat, it hardly seems possible that such operations could have been carried on at an appreciable profit. At some of the small power-plants it was stated that ground carrying as low as a tenth of a carat per cubic yard could be handled profitably, and this seems entirely likely, considering the high value per carat of the Vaal river diamonds.

The question of the percentage of extraction made in the treatment above described is also one on which only limited information is obtainable. In regard to the oversize and undersize discarded, it must be admitted that in some cases the former is roughly inspected for diamonds, but the latter is always a source of loss, as it is certain that diamonds smaller than 6 or 8 mesh exist in the gravel. As to the efficiency of the washing pans on the material passing through them, it is probable that this is fairly high, for had it not been it seems likely that at least in some cases provision would have been made to re-treat the overflow passing to the tailing dump.

Carrie Everson.—American metallurgists are now making an attempt to collect the history of Carrie Everson and her flotation experiments. Even her identity is not established. It has been said that she was the sister of a Colorado assayer and that she discovered flotation when washing her brother's ore-sacks. According to the Denver *Times*, she was the wife of a Doctor Everson, at one time practising in Chicago and later settling at Denver on account of his health. A banker at Denver is reported as saying that Dr. Everson originated the idea and that his widow continued the experiments after his death.

GLASS-TOP CONCENTRATING TABLES

THE following particulars relating to a trial made on Martin's glass-deck table by Messrs. Bewick, Moreing & Company at the East Pool mine, Cornwall, will be read with particular interest at this time. As we point out elsewhere, and as the engineers of the firm fully realize, this test does not give a final answer to the question of wooden versus glass decks, but we are glad to print the results because the test was made with particular care and accuracy, especially as regards sampling.

The frame used in the test was an ordinary 18 ft. round, having for its concentrating surface corrugated glass with a pitch of 1½ in. per foot, the glass being placed on a special bed in flat sheets cut to fit the frame, and the joints between the glass made with cement. Mr. Martin personally supervised the laying down of this surface. The grade of the table appeared slightly too steep for the product fed, and owing to the glass being perfectly flat the pulp flowed over it in a straight line instead of converging toward the centre, thus causing a considerable increase of flow to take place at the joints between the various sections of glass. This was detrimental, as the following assays will show: Two samples were taken at the centre edge of the glass, one being taken over 8 in. in the centre of the sheet and the other taken simultaneously across the joint for a distance of 2 in. on either side, or a total of 4 in. The samples were taken as the frame revolved from the commencement of the feed until the cut-off of the concentrates, and the bulk of the pulp compared in ratio to 1 in the centre to 4 in the joints, although the former was taken over twice the area of the latter. The assay results were: Centre of glass sheet, 5 lb. per ton; joint of glass sheet, 7·5. Better results would probably have been obtained if the pitch of the table had been slightly less and the glass properly cast to suit the circumference of the frame and the pitch.

The wooden frame was an ordinary 18 ft. round, having a pitch of 1¼ in. and 5 ft. width of deck. This frame was exactly similar to that on which the glass surface was fixed. The tests in both cases were run over a period of 16 hours. The concentrates from the two frames ran into separate pits and subsequently weighed, the dry weights being: glass frame, 847 lb.; wood frame, 1557 lb. The feed, concentrates, and tailings were sampled continuously by automatic samplers, and the samples were evaporated, and assayed:

	Glass frame	Wood frame
Feed, lb. per ton...........	9·2	9·2
Concentrates, lb. per ton	32·2	15·0
Tailings, lb. per ton.......	6·5	6·5

In order to arrive at the tonnage treated, a flow sample was taken every hour, and the average flow was taken as the basis in calculating the amount of pump treated in the 16 hours. The glass frame treated 3·8 tons dry in 16 hours, and the wood frame 2·54.

The results in tabular form are given below:

GLASS FRAME.

Product	Weight	Value	Wt. × val.	% weight	% value
Feed	8412	9·2	—	100·0	100 0
Head......	847	32·2	3·220	10·0	35·5
Tail........	7865	6·5	5·850	90·0	64·5
Total...	8412	9·0	9·070	100·0	100·0

WOOD FRAME.

Product	Weight	Value	Wt. × val.	% weight	% value
Feed	5690	9·2	—	100·0	100·0
Head......	1557	15·0	4·094	27·3	46·4
Tail	4133	6·5	4·725	72·7	53·6
Total...	5690	8·8	8·819	100·0	100·0

The pounds of tailing and feed in the above are calculated from the flow, the concentrates being accurately weighed.

Results may be recapitulated as below:

	Glass frame	Wood frame
Pounds of feed treated	8412·0	5690·0
Assay value in lb. per ton...........	9·2	9·2
Pounds of Sn in total feed.	35·0	23·4
Pounds of concentrates...............	847·0	1557·0
Assay value in lb. per ton............	32·2	15·0
Pounds of tailings	7565·0	4133·0
Assay value in lb. per ton...........	6·5	6·5
Pounds of Sn. in concentrates	12·1	10·4
,, ,, ,, tailings	21·9	12·0
,, ,, ,, both products ...	34·0	22·4
Extraction, %........	34·7	44·4

Both concentrates contained a considerable amount of sulphide, the glass concentrate containing a greater proportion of arsenic and copper. Before starting operations, tests were made on the capacity of the table, varying the feed from 4 tons to 10 tons per 24 hours, and it was found the best results were obtained when handling from 4 to 6 tons per 24 hours. We may add that the sampling upon which these results are based was done with a particularly efficient automatic sampler shortly to be described, we understand, before the Institution of Mining and Metallurgy.

DISCUSSION

Australian Mine Tax.

The Editor:

Sir—In your Editorial Note on the article written by me, and published in your issue of August, regarding the Australian Land Tax, and its effect on mines, you state that in practice the taxing of ore reserves, with reasonable moderation as to rates, does not discourage advance development. As I consider that this tendency, with regard to the more profitable mines, is a serious defect in the application of the tax, I am writing this.

With valuations based on the formula described in my article, the taxing rates would, in the case of the best mines with long terms of lease unexpired, rapidly exceed reasonable moderation as their ore-reserves were increased. In such cases the rate of tax may well become a serious deterrent to advance development beyond certain necessary minimums.

We will take a hypothetical example. A mine has ore reserves sufficient for one year's operations, say, 150,000 tons, having an extractable gross value of £400,000. The cost of development is 3 shillings per ton, including shafts. Total cost of plant, etc., is £150,000. Cost of treatment is 30s. per ton. Unexpired term of lease is 15 years. In this case the capital required may be taken as £200,000. For each additional year of advance development, that is, each additional 150,000 tons in ore-reserves, £22,500 would be added to that sum. Thus with ore reserves of one year the gross extractable value less the cost of treatment, plant, and development would give no value for taxation purposes. With ore-reserves of four years, there would be a gross extractable value of £1,600,000 in 600,000 tons. The cost of development would be £90,000, and the capital required would be £267,500. The cost of treatment would be £900,000. Thus £1,600,000 less £1,167,500 (=£432,500) becomes the figure on which the taxation would be based. We will suppose that interest on cost of plant and development and other deductions reduced this sum to £400,000; 4½% on £400,000 multiplied by the number of years of unexpired lease (15) gives £270,000. Deduct the exemption of £5000, and £265,000 is left as the figure on which the tax would be rated and paid. Of this £75,000 would be rated at 5d. in the £ and £190,000 at 9d. in the £, or an average of 7·87d. The amount of the tax per annum would be approximately £8700. If the lease had its full 21 years to run the valuation would become £373,000, the average taxing rate 8·2d. in the £, and the yearly tax approximately £12,750.

The above figures are not absolutely accurate, but sufficiently so for the purpose of exemplification. Certainly the hypothetical mine is a rich one, and yields a large yearly profit. Even so, taxes on the above scale might well affect the policy as to advance development. As will be seen, they greatly exceed the interest on the capital laid out in development.

In the case of a mine, situated as above, I should say that the average company would have its ore developed about two years ahead. It would not exceed this, at all events until the unexpired term of the lease was greatly reduced. Of course with a decreased term of unexpired lease, the inducement to withhold forward development would gradually disappear, to jump suddenly to its maximum at the end of the lease period, if a further lease were entered upon, which is the case in nearly all profitable mines.

With ore-reserves of two years, the gross extractable value is £800,000 in 300,000 tons; capital requirements are £222,500, and cost of treatment £450,000. This gives £127,500 as a basis for calculating; 4½% on this, multiplied by 15, gives approximately £81,000. With the exemption of £5000, this gives £76,000 on which to be rated and to pay. The rate is about 5d., and the annual tax about £1600.

The above figures show that as the advance development increases, the tax increases at a much more rapid rate. It is this which places a heavy discount on doing development beyond what is really necessary.

The fact that the average mine is little or not at all affected by the tax is of such importance that I again mention it. This should be borne in mind by investors.

Personally I think it highly probable that, as the inconsistencies and inequalities of the basis of valuation become recognized, the basis will be altered, though I do not doubt that the tax itself has come to stay.

To the principle of the more profitable mines paying higher rates of tax most will not object, and there is nothing in that principle to discourage the working of the mines to the greatest possible profit. The principle is well recognized in modern taxation. It is to special features in the valuation that efforts should be directed with the object of effecting alterations.

H. R. SLEEMAN.

Perth, W.A., November 18.

[Our comment had in mind the general principle. Obviously it is possible to levy any tax so as to discourage development, but a tax on ore reserve, if moderate in amount and if fair depreciation be allowed, does not operate to discourage advance development, as has been shown by experience in several American States. The reason is that the advantages, technical and financial, of having a large reserve, offset the extra cost. We have never discovered any ideal system of taxing mines, and our correspondent is sound in concentrating attack upon the particulars of the scheme rather than the plan itself.—EDITOR.]

The Vanning Assay.

The Editor:

Sir—In the note by Francis Drake in your December issue, the suggestion is made that 224 grammes should be taken as a unit basis. Should not this be 224 grains? I make it so.

CRITIC.

London, December 17.

[Our critic is quite right, and the fault is ours, an abbreviation 'gr.' having been expanded wrongly and the error not detected until too late.—EDITOR.]

Comforts for the Tunnelling Companies.

The Editor:

Sir—There are tunnelling companies other than 174 mentioned in your last issue who would be very glad of any comforts that you may collect.

All good wishes!

T. M. LOWRY,
Captain, R.E.

173 Co. Royal Engineers,
B.E.F., December 21.

[We take pleasure in endorsing Captain Lowry's letter, and we reproduce above the Christmas Card he sent us. It shows that our friends at the front do not lose their sense of humour despite their temporary diversion of energies. Looking at the drawings carefully we feel sure we will be absolved from publishing technical information that may convey information to the enemy. After the war is over we hope to have the privilege of printing descriptions of the mining methods employed by the engineer corps of the various armies in the field. They reflect a great improvement, we may say, on those employed by our American friends in advance of apex suits.—EDITOR.]

Sulphuric Acid.—The scarcity of sulphuric acid, owing to its great demand for the manufacture of explosives, is making users cast about for substitutes. Arrangements have been made by the Government to supply cheaply their waste nitre cake, sometimes called salt-cake, a waste product obtained in the manufacture of nitric acid from nitrate of soda. This nitre cake contains about 30% of sulphuric acid, and for many purposes in connection with the woollen and textile industries it may be used instead of sulphuric acid itself. The difficulty is that it is troublesome to transport and handle, and care has to be taken that it does not get wet, for the escaping drainings would cause great damage.

SPECIAL CORRESPONDENCE

MELBOURNE.

THE METAL EXCHANGES of Sydney and Melbourne are now formally, if not legally, established. Meetings held in Sydney and Melbourne elected committees and chairmen, and regulations are being discussed. The metal exchanges are the outcome of the work of Mr. Hughes, the Commonwealth Premier and Attorney General, having for its object the elimination of the German factor in the metal trade of Australia. Under the rules of the metal exchanges no export can be made, nor any sale or purchase of Australian metals or minerals, without first registering all particulars at one or other of the Exchanges through a member. No person or firm can be a member unless British born and approved by the Attorney General. Various rules have been adopted by the Exchanges, covering qualifications, fees, elections, sales, contracts. The objects of the Exchanges are defined as: "To exchange quotations, to facilitate the purchase and sale of metals and minerals in Australia, to provide for the registration of all contracts appertaining to the sale, treatment, and refining of all metals and minerals other than noble metals, the registration of metallurgical chemists and assayers, to maintain honourable dealings between members of the Exchange, and to promote the interests of Australia and of the British Empire in relation to the purchase and sale of metals and minerals." It is this last sentence that really defines the objects. By restricting the sales to the British Empire only it is expected to benefit both sellers and buyers.

These objects are laudable and are thoroughly approved by all sections of the Australian public. The fear, however, is that the producer will be unduly penalized. In effect, the Australian metal exchanges differ from others, as they will not only deal in finished metals, but also in ores and intermediate products, such as mattes and concentrates. The conditions of membership preclude any but large producers being represented, for a small mine cannot afford to pay 50 guineas entrance fee, 15 guineas yearly subscription, and give a bank guarantee of £1000. A small mine selling a parcel of ore over £500 in value has to pay a registration fee or toll of 1s. per £100, and in addition to pay a member a fee for transacting his sale to a smelting company. The charges of this smelting company to the producer will also be increased by these same fees, as the metal produced from the ore has again to be registered, and sold on the Exchange. The brokerage fee is not yet fixed. A certain clique imagines that there will be a good thing to be made out of brokerage fees. As the base metal trade of Australia may be put at about £8,000,000 yearly, a fee of only ½% would give £40,000 annually to be divided among less than 40 brokers. It is hoped, however, that the committees will so arrange matters and regulations that the producer is not penalized. One argument brought forward was that since the German influence was abolished, the prices would be better, yet the prices of all transactions will still have to be those of London and New York, and in the days after the war the decrease of competition must harm the producer.

The effect of the establishment of the metal exchanges is to put the control of the whole of the base metal trade into the hands of the Federal Government. The lesser minerals, molybdenite, wolfram, antimony, etc., come within the scope of the Exchanges, and any day an edict from the Attorney General may include also coal and iron. The control of the trade and consequently of the whole base metal industry, is further increased by the prohibition of export of any unrefined copper. This regulation may be extended to lead and tin. As for copper, hitherto a certain quantity of ore from West Australia, and matte from other parts, as well as large quantities of blister copper, have been exported to England and America. Local works are today unable to absorb the output of blister, matte, and ore. The Electrolytic Company at Port Kembla can today take at most 2000 tons monthly. To take the output of blister from Mount Lyell, Mount Morgan, Hampden, Elliott, Cuthbert, and Great Cobar, as well as the auriferous mattes from the smaller mines, would require a monthly capacity of over 3500 tons. It is doubtful whether these mines would find it expedient or profitable to send their blister to these works and pay monopoly charges. The whole problem is still to be solved, possibly by new works being erected in suitable places.

BROKEN HILL.—The idle mines at Broken Hill are Block 10, British Broken Hill, and Junction North, and until recently Junction. All these have mills and could make lead and zinc concentrates, if there were a market. Block 10 could mill for at least another year on proved reserves, and at costs last recorded and present prices of lead could make a good profit, if they had a market. The Port Pirie works cannot yet take their lead concentrate, so meanwhile Block 10 is turning its surplus energies, and cash, to the development of a big gold property at Misima Island off New Guinea. The British, being a company registered in London, had to wait the decision with regard to enemy contracts, and even when this case is decided, they must still wait for an Australian market, as the Federal Government prohibits exports of 'unfinished' metals. The Junction North had a running contract with Broken Hill Proprietary, while the Port Pirie works still belonged to that company. When these works were taken over by the Associated Smelters the Proprietary repudiated this contract on a technical point, according to the report of a recent meeting of Junction North. The Junction has been sending a few parcels of rich ores to the Sulphide Corporation mill at the Central mine, as their own mill is not efficient. The recent prohibition of export of 'unfinished metals' so far only affects lead concentrate, copper ore, matte, blister copper, and tin concentrate. To a certain extent it affects also lead bullion.

DENVER, COLORADO.

MINING conditions are looking better here, and there has been lately a notable increase in the demand for both machinery and men. Many of the latter have been called to Mexico and to other foreign countries, but not all the good things are abroad, and there is a general revival of interest throughout the state. The demand for tungsten has made Boulder county happy and production has begun near Silverton. In many parts of Colorado old properties are being re-opened or new ones brought into production. A case of the latter is the Derry Ranche gold dredge, which has just closed down for the winter after a two months' run in which it almost repaid capital cost leaving future profits for 'velvet.' Derry Ranche is about twelve miles below Leadville in the Arkansas valley, and the dredge is near the D. & R.G. railway. The property consists of 2000 acres, of which 125 has been so far drilled, and proved to contain gold. Some years since the ground was tested by W. H. Radford, and it has since been checked by other Californians, but the owners, who formerly held the ranche at $300,000, were unable to make terms with any operator. Last year A. C. Ludlam, of the New York Engineering Co., obtained the right to dredge the ground on a royalty, and reconstructed an old dredge for the job. Extensive minor changes were made, so as to bring down the power bills and other operating charges to about 4½ c. per cubic yard. In the two months that the dredge was run this fall it handled 148,000 yards averaging about 47½ c. per yard, this

GOLD DREDGE AT DERRY RANCHE, COLORADO.

running about 15% above the estimates from drill holes. The operating expenses for the two months were $3350 and $3600, the increase for the last month being due to ice in the pond, as the thermometer stood at 18° to 20° below zero. It is expected that when work is resumed in the spring equally good results can be achieved for four or five months, after which the dredge can work some time in 30 c. ground. Mr. Ludlam's success with this venture has set a lot of mining people wondering why other small dredging properties cannot be found.

TORONTO.

ONTARIO GOLD AND SILVER.—Returns made to the Ontario Bureau of Mines of the metallic production of the province for the first nine months of the year, show a considerable increase in the gold output, almost sufficient to counterbalance the falling off in silver. Gold was produced of the value of $5,826,941, the increase over the output for the corresponding period of 1914 being $1,884,093, while the value of the silver produced was $8,030,469, a fall of $2,051,760. The combined value of the precious metals for the nine months was thus only $167,661 less than for the same period last year, and with the subsequent increase in gold production and the revival of activity in Cobalt, the output for the whole year of gold and silver combined will show a substantial increase. The nickel output of the value of $5,369,536 is $1,345,980 in excess of that for the first nine months of 1914.

PORCUPINE.—The November output of the Dome is the largest for the year, being valued at $160,000, from the treatment of 28,600 tons of ore of the average value of $5·59 per ton. The net earnings of the company for the six months ended September 30 were $433,902. The balance on hand at that date was $837,500. Good progress is being made with the new central shaft which is expected to be sunk to the 700-ft. level by March. The improvements are being planned with a view to a greatly enlarged scale of operations in the future, as the winding machine to be installed will have a capacity of 75,000 tons per month, which will be considerably greater than will be needed for some time. The Hollinger made a new record by its latest 4-weekly statement for the period ended November 4, the gross profits for which were $184,769 from the treatment of 28,401 tons of ore of the average value of $10·34 per ton, the working costs being $3·29 per ton milled. The mill is now treating about 1500 tons per day and it is anticipated that when the extensions now in progress are completed, its capacity will be increased to 1900 tons per day. Arrangements under which the McIntyre Mines takes over the Jupiter property have been completed. A new company under the name of the McIntyre-Jupiter Mines, Ltd., capitalized at $2,000,000 in $1 shares, will be formed to which the assets of the Jupiter will be transferred. The McIntyre is to take 955,000 shares at the price of $152,000, and the old Jupiter company will receive 943,893 shares in the new concern and $60,000 in cash. Important new ore deposits have been discovered on the McIntyre. Diamond-drilling from the 700-ft. level of No. 5 shaft has cut a wide orebody 760 ft. from the surface assaying $18 to the ton. Another has been found by cross-cutting from No. 5 shaft on the 500-ft. level, stated to assay upwards of $21 to the ton. At the Preston-East Dome diamond-drilling has shown a mineralized zone 200 ft. in width, traversing the property for 2000 ft. Some promising veins have been disclosed and surface development is being undertaken. The shareholders of the Dome Extension have authorized the directors to sell 1,000,000 shares at 25 cents per share to raise funds for development. The Tough Oakes, in the Kirkland Lake district, has been put on a regular dividend basis at the rate of 10% per annum, payable quarterly.

COBALT.—The silver mining industry has fairly entered upon an era of renewed activity consequent upon the increase in the price of silver. While shipments have considerably increased, some of the operators are still holding back in the expectation of further increase in the price. Attention is being paid to some old prospects, which have not been worked for years. The Nipissing in November mined ore of an estimated net value of $164,846, and shipped bullion from Nipissing and custom ore valued at $275,767. Considerable additions were made to its ore reserves during the month. The quarterly report of the Beaver Consolidated for the period ended November 30 showed cash on hand $122,674, and bullion and silver ore on hand at smelters and in transit 220,015 oz. Additions to the mill have been completed, and it is now treating ore to the amount of 125 to 150 tons per day. The main shaft has reached a depth of 1235 ft. The Coniagas has purchased the old Agaunico mine on Lake Timiskaming, formerly a producing property, upon which little development has been done. The Ophir Cobalt, a promising property closed down some years ago, is being re-opened. The Ontario government has exempted the Crown Reserve from the payment of its 10% royalty owing to the decrease in its output. The Chambers-Ferland has struck rich ore from the new shaft, the vein about 2½ in. wide carrying from 2000 to 3000 oz. of silver. A new vein found on the Cobalt Comet, formerly the Drummond, is showing up well at depth, carrying from 4000 to 5000 oz. of silver per ton at 20 ft. A shaft is being put down on it to connect with the old workings.

KOWKASH.—Very little development has been done in this district, and on that account the Ontario Bureau of Mines has withheld from publication the latest report of Percy E. Hopkins, considering it inadvisable to give further information until sufficient work has been done on which to base a definite conclusion. The original King Dodds discovery failed to realize the high expectations excited by the rich surface showing, as the vein pinched out at the depth of a few feet. The claims farther west along the line of the National Transcontinental Railway are more promising. A thorough examination of the district will be made by the officials of the Bureau in the spring.

WESTERN AUSTRALIA.

LOW-GRADE MINES AT KALGOORLIE.—The sale of the Chaffers mine by the liquidator, and subsequently by the purchaser to the Lake View & Star Ltd., has created considerable interest in mining circles. This mine has been a sink for capital for many years, but will under the new ownership be handled under conditions which should enable its orebodies to be worked at a profit. This principle will become a big factor in the future of the Golden Mile. A number of smaller companies have taken out all the richer portions of their ore reserves, leaving a much greater proportion of low-grade ore, which is not profitable to them. Then as the larger mines, which are equipped and organized to treat large quantities of low-grade ore, gradually deplete their own reserves, they will absorb their smaller neighbours. Tributers also will help to keep up the yield of gold, but at present they are not tolerated on the big mines, as their prospecting work is apt to interfere with the main operations of the mine. The future of several of the companies, which have well equipped treatment plants, but whose output is now just sufficient to pay working expenses, will depend on the acquisition of adjacent mines, or the throwing open of portion of their mine to tributers. If the former method can be carried out it is more satisfactory, but failing that, there are advantages to be gained by tributing, especially if worked on the share system. There is no getting away from the fact that underground managers are not, as a rule, good prospectors, their very training making them look for footage driven and tonnage broken, rather than devoting time in following indications as a tributer does. The majority of miners do not observe the country passed through, except for its hardness, but there are some with the prospector's instinct, who note all these things for future possible tribute. There are many places on which the men are waiting to do some more work. Of these probably the greater proportion would fail to improve with development, but there would be others that would pay the tributer well, and at the same time supply ore for the company's mill.

The developments on the Lake View portion of the Lake View & Star mines at, and below, the 2100-ft. level are most satisfactory. A winze has been sunk 110 ft. below that level, where the average value of the ore is 50s. per ton over a width of 72 in., the last 5 ft. averaging 80s. over that width. The end of this mine was announced to be in sight some years ago, but by a careful system of prospecting, followed by judicious development, they are enabled to keep the mine well ahead of the mill, and with the acquisition of the Chaffers they should be able to keep going for years.

AT THE IVANHOE the diamond-drill borehole from the east plat at the 3470-ft. level has been completed. The porphyry dike was passed through at a vertical depth of 3744 ft. It is interesting to note that Dr. Malcolm Maclaren estimated that at the worst they might expect to cut through the porphyry dike at a depth of 3760 ft. He said: "There is no reason whatever to anticipate that the lode in the quartz-dolerite below the porphyry will differ materially in size, tenor, or length of shoot from that worked above the porphyry." The result of this work will be watched with keen interest, as it is being conducted on the advice of Dr. Maclaren to test the value of the orebodies beneath the porphyry dike.

WESTONIA.—Although attempts have been made to arrange for an amalgamation of the Edna May and the Deep Levels companies, neither feels inclined to give way sufficiently to tempt the other. The result is that the former is installing a pumping plant capable of dealing with half a million gallons of water per day, and has already increased its power and treatment plants. The Deep Levels is drying its shaft by boring a series of holes around the shaft and pumping cement through them into the interstices of the country. This method was adopted as the company had not sufficient pumping plant available to cope with the water while the shaft is being sunk. So far the shaft has been sunk from 359 to 385 ft. under this scheme; no difficulties have arisen, and the shaft is going down dry. It will be interesting to watch the cost of this method against that on the next mine where the water is pumped out. The Deep Levels has purchased a ten-stamp mill, which is now being erected to treat the ore which they hope to develop from the shoot cut by the borehole. This to say the least is rather a premature proceeding. When it is considered that the Edna May ore-shoot is shortening with depth, it seems unfair to the shareholders of both companies that so much money should be spent in duplicating both the power and treatment plants. If the companies were amalgamated, the plant on the Edna May would be sufficient for the work, and the Deep Levels could supply the ore after the reserves in the former had been worked out. Perhaps wiser schemes may yet prevail.

SAN FRANCISCO.

THE RARER METALS continue to attract an unprecedented amount of attention. There are now three antimony smelters on the Pacific Coast, at Seattle, San Francisco, and Los Angeles. Mr. John Henry Rickard, formerly in the antimony district of southeastern France, is expected shortly from England to take charge of the antimony smelter of the Chapman Smelting Co. in San Francisco. Ores are being obtained from the Fairbanks district of Alaska, which produced $150,000 in antimony ores during the season of 1915; also from the Cœur d'Alene district of Idaho, from Humboldt county in Nevada, and from southern California districts. The high price paid for ores of tungsten continues to stimulate prospecting for wolframite, huebnerite, and scheelite all over the West. The Boulder county mines of Colorado are busy; the Atolia district of San Bernardino county in southern California is enjoying a tungsten boom; shipments of tungsten ore are being made from the Wasp No. 2 gold mine in the Black Hills of South Dakota; several scattered mines are producing tungsten ores in Arizona, and developments are in progress in Humboldt and White Pine counties of Nevada. An interesting feature of tungsten ore is its occurrence in veins bearing gold, as in the Wasp No. 2 gold mine, in the Union Hill gold mine at Grass Valley, and in Colorado.

MEXICAN AFFAIRS are gradually assuming a more hopeful aspect. Villa's forces are being defeated in Sonora, and his last resources are crumbling beneath the more powerful combination of the Carranza party. A mine superintendent writing from Nogales, Arizona, remarked, "we expect soon to be able to hold a *post mortem* over the remains of our property in Sonora." Shipments of mining machinery are commencing to arrive at points in northeastern and central Mexico; the Southern Pacific and other railroads in the United States are now permitting their freight-cars to enter Mexico, and this addition to the equipment of the National Railways of Mexico will enable the more prompt handling of ore between the mines and smelters, and the hauling of supplies and other products. The smelters at Monterrey, San Luis Potosi, and Aguas Calientes have ordered large quantities of coke, which will soon begin arriving from the United States. Several mining companies have re-opened their offices, including the Compañia Minera de Peñoles, which operates at Mapimi, Durango, and has established new offices at Monterrey.

THE OATMAN district of Mohave county, Arizona, the scene of a considerable gold 'rush,' has been visited by several prominent engineers. Mr. Frank H. Probert says of it: "Oatman is a typical boom camp of mushroom growth, with one exception—it has no saloons. Arizona went 'dry' on January 1, 1915. The bars, foot-rails, glassware, and white-vested bar-tenders remain, but thirsts are now quenched and success toasted with grape-juice or malted milk. Where the veins outcrop they appear as prominent silicified ribs in the softer andesites or as shallow depressions in the quartz-porphyry or rhyolite, all showing more or less brecciated fragments cemented by calcite or quartz; most of the veins trend to the northwest. The ore occurs as a series of lenses pinching vertically and horizontally within the veins; owing to the re-opening of fractures, oxidation and leaching are advanced. Gold is seldom found near the surface in paying quantity. The rich oreshoot of the United Eastern apexed 300 ft. below the surface; the first ore mined in the Tom Reed was even deeper. Hence exploration shafts are sunk 300 to 500 ft. before cross-cutting to the vein." This is quoted from the proofs of an article to appear shortly in the *Mining and Scientific Press*.

FLOTATION.—This process is receiving steadily increasing attention. Apart from the numerous new applications of the process to copper ores, there is more public discussion of the principles underlying the process; for instance, while no paper on flotation was read before either the International Engineering Congress or the annual meeting of the American Institute of Mining Engineers, it is noteworthy that the local section of the American Institute here in San Francisco devoted an evening this week to a discussion of the process and will probably set aside several other evenings for the same purpose. An effort was made to get the local representative of the Minerals Separation Co. to open the discussion, but he could not get the consent of headquarters, so that, by the irony of fate, a metallurgist in the employ of the Miami Copper Co. took his place. It had been intended, in default of Mr. E. H. Nutter, to get Professor Franklin of Stanford University to give an outline of the physicochemical principles, but he was prevented from coming at the last minute, so that Mr. R. C. Canby took his place. The discussion that ensued was most interesting, but, as you can imagine, it disclosed discrepant notions concerning the fundamentals of the process.

PERSONAL

RALPH ARNOLD returned from Venezuela to California late in December.

CHARLES A. BANKS has received a commission in the Tunnelling Section of the Royal Engineers.

S. C. CLAVELL BATE is expected in England from Nigeria.

J. MACKINTOSH BELL, who is now Major in the Canadian Highlanders, is expected in London shortly.

C. P. BERNARD has gone to the Belgian Congo.

EDGAR BONDS is home from West Africa.

HENRY BRELICK has left for the Argentine.

STANLEY C. BULLOCK, on the expiry of his contract with the Poderosa Mining Co., has returned from Chile with the object of joining His Majesty's Forces.

THOMAS P. CARR is in England on short leave from Rio Tinto, Spain.

M. F. CHASE and W. D. MAIN have resigned from the staff of the New Jersey Zinc Co. to enter business for themselves.

PETER CLARKE was in London on leave recently paying a welcome visit to friends.

DURWOOD COPELAND, of the Compania Estanifera de Llallagua, Bolivia, passed through London after a trip through the Malay tinfields.

H. O. CRIGHTON, who recently returned from Northern Nigeria, has received a commission in the Royal Engineers.

JAMES CROZIER is manager of the mines of the Cape Copper Company in South Africa.

Z. CUSHING is now in charge of the Technical Department of the Atlas Powder Co., at Wilmington, Delaware.

T. W. EDGEWORTH DAVID, professor of geology in Sydney University, has volunteered for active service, and has been appointed geological expert to the mining branch of the Royal Engineers, with the rank of major.

B. F. DAVIS is coming home from Chile.

W. R. DEGENHARDT has gone to Western Australia.

F. H. EVANS is manager of the Cockle Creek smelting works of the Sulphide Corporation.

COLIN FRASER is in munitions work at Sydney, Australia.

CHARLES A. GIBBONS, Jr., has resigned the position of mine manager to the Central Chile Copper Co. and has returned to the United States.

ANDRE P. GRIFFITHS has resigned as general manager of the Dos Estrellas gold mine at El Oro, Mexico, and has been elected to the board of directors of the company. T. Skewes Saunders, the assistant manager, succeeds him as manager.

SIR ROBERT HADFIELD has joined the board of the Mond Nickel Company.

W. T. HALLIMOND is expected from Johannesburg.

F. H. HAMILTON has returned from Canada.

E. C. B. HEDEN is on his way home to England from Queensland.

CHARLES R. VAN HISE is chairman of the Commission appointed to investigate the causes of the slides in the Panama Canal.

GEORGE T. HOLLOWAY has returned from Canada on the conclusion of his investigations as to the nickel position on behalf of the government of Ontario.

G. H. HONE is valuing mines in New South Wales for the Commonwealth Government, in connection with the new taxation proposals.

AUSTIN F. HOY, European representative of the Sullivan Machinery Company, is on a short visit to the United States.

DUDLEY J. INSKIP has returned to the Mawchi tin and wolfram mines in Burma.

REIJI KANDA has completed his work in Burma and returned to Japan.

W. W. LAWRIE has been appointed manager of the Nourse Mines in succession to R. A. Barry, who is now manager for the Transvaal Gold Mining Estates.

J. H. MACKENZIE has succeeded F. W. Bradley as president of the Alaska Treadwell. P. R. BRADLEY becomes consulting engineer to the Treadwell and Alaska Juneau properties, RUSSELL WAYLAND succeeding him as general superintendent at Treadwell, and L. H. METZGAR becoming assistant superintendent.

BENJAMIN MAGNUS, lately manager of the Mount Morgan, is touring the copper districts of Utah, Montana, Arizona, and Tennessee.

L. J. MAYREIS has gone to Rotterdam for the Commission for Relief in Belgium.

J. W. MOULE, formerly with the Mount Morgan company, has been appointed manager of the Pernatty copper mines, near Port Augusta, South Australia.

J. MALCOLM NEWMAN has returned to Sydney after a visit to the tinfields of Malaya and Siam.

PETER N. NISSEN has been home on leave from France.

CHARLES OLDEN is manager of the Rakha Hills copper mine in Chota Nagpur, India, belonging to the Cape Copper Company.

W. H. PAY has been appointed Acting Chief Inspector of Explosives in the Transvaal, during the absence on military duty of Major A. B. Denne.

HENRY M. PAYNE is expected from Petrograd.

W. H. PERKIN has been appointed adviser to the British Dyes Company, Ltd. He is professor of chemistry at Oxford, and is a worthy successor to the genius of his father, Sir W. H. Perkin, who originated the aniline dye industry.

THOMAS T. READ has joined the staff of the New Jersey Zinc Co. He has also been offered the appointment as adviser to the Chinese Government on exploratory work.

EDGAR RICKARD intends to sail for New York on January 18.

EDWARD RILEY & HARBORD have moved their City office and laboratory from 2 City Road to 6 Finsbury Square. Their Westminster address remains at 16 Victoria Street.

A. TREVOR ROBERTS sails for Naraguta, Nigeria, on January 26.

E. MILES SHARP is manager of the New Modderfontein mine in the Far East Rand.

W. E. SIMPSON is leaving for New York on his way to Northern Ontario.

J. D. AUDLEY SMITH has changed his address to Dibbs Chambers, 58 Pitt Street, Sydney.

ARCHIBALD STARK is here from Rio Tinto.

GEORGE E. STOTT is here from China.

J. M. TURNBULL has been appointed Professor of Mining in the University of British Columbia.

SCOTT TURNER is leaving for New York at the end of this month.

J. B. TYRRELL will be in London at the end of the month.

T. F. WILKINS, who was recently engaged in mining in German South-West Africa, has gone to Burma.

W. WILLIAMSON is coming home from Naraguta, Northern Nigeria, and he will be in Cornwall for three months.

M. YAMOSHITA, of the Ikuno mine of the Mitsui Besshi Co., has been visiting tin mines in Cornwall.

METAL MARKETS

COPPER.—Standard sorts, after the strength shown recently, opened the month of December with a decline which carried the three month price down to £77 on the 8th. Prices then rallied, and the month closed at £82 2s. 6d. cash, and £86 three months. Refined copper has not fluctuated in the same manner, having shown great steadiness, while standard declined, and sharing to the full in the advance. It is now selling at £109 against £99 when December opened. American producers can practically dictate their own terms, and are quite independent of fluctuations on the London Metal Exchange. Their price has risen from 19¾ to 22½ cents f.o.b. New York. Second-hands are able to do very little business. Consumers in England have on the whole been very quiet, although inquiry became somewhat brisker toward the end of the year, but some good business has been done in France, and American consumption is important. On the other hand the British government has purchased 60,000 tons in America with a view to distribute it among the munition works on this side. The effect will probably be to keep the market steady at a high level. This action should have been taken when first mooted months ago, and prices were £30 lower. The shipping shortage continues to exercise a serious influence on the market. Warehouse stocks in this country are declining steadily, and so long as the demand continues and shipment remains so difficult in spite of high prices, this condition is likely to persist. Japan is out of the market, having sold all available production to Russia.

Average prices of cash standard copper : December 1915, £80. 17s. 10d. ; November 1915, £77. 16s. 10d. ; December 1914, £56. 18s. 5d. ; average for year 1915, £72. 12s. 9d.

The exports of copper from the United States during 1915 totalled 257,915 tons as compared with 375,101 tons in 1914 and 382,810 tons in 1913. Sulphate of copper is quoted at £46 per ton. Copper sheets £125 per ton, tubes 14½d. per lb., wire 13½d. per lb. ; brass sheets 15d. per lb., tubes 14½d. per lb., wire 14½d per lb.

TIN.—The market has been steady with quite a good undertone. Prices closed for the month of December at just about the same level as they opened and the daily fluctuation has been trifling. This speaks well for the immediate future of the market and indicates that the bottom has been reached. The turnover on the Metal Exchange is light, indicating an absence of speculative interest. On the other hand, the consumption is steady and in this country indicative of lively trade. In America, the metal is in eager demand, and considerable excitement has been awakened there by government restrictions on exports from British possessions with a view of creating a reserve stock. This action had a temporary result in lowering prices in London while advancing them sharply in New York. Toward the end of the month licences were more readily granted but the effect on prices was not marked. The restriction in shipping facilities and, still more, the danger of losses by hostile submarines in the Mediterranean is likely to have an important influence on prices, and may give rise to violent fluctuations. The Straits have sold well both for home and for America at well over London points, but little has been doing in Banca because of unfavourable exchange. Little has been heard of Russian demand owing to interruption of communications. The Welsh tinplate factories are now controlled establishments.

Average prices of cash standard tin : December 1915, £167. 3s. 10d. ; November 1915, £167. 18s. 5d. ; December 1914, £147. 4s. 4d. ; average for the year 1915, £164. 4s.

LEAD.—There has been great firmness in prices, due more to the absence of shipping facilities than to any abnormal demand. Munitions are taking a large and steady tonnage, and makers of chemical sheet lead have also been consuming largely. The American price shows a steady advance and now stands at 5·75 cents f.o.b. New York. Spanish arrivals have been very restricted, although there are moderate stocks lying at shipping ports ; freight difficulties, however, appear insuperable. Australian lead is coming forward slowly, and much of the metal afloat lies on Government transports, and is not available for consumption. China has appeared as a buyer on the London market and is paying good prices. Export business is dead, licences having been refused wholesale. The interruption of communication with Russia has also affected business. Owing to labour difficulties desilverizers in this country are unable to avail themselves of the large quantities of silver lead coming forward. The closing price for the year is £30.

Average prices of soft foreign lead : December 1915, £28. 8s. 8d. ; November 1915, £26. 2s. 9d. ; December 1914, £18. 18s. 4d. ; average for year 1915, £22. 17s. 8d.

SPELTER.—Prices are irregular with heavy fluctuations. The month of December began with a declining tendency which took the London official quotation down to £78–£68. Since then there has been a recovery to £88–£78. Spot metal is scarce and commands a considerable premium. America keeps steady, and offers made to this side are generally for March onward, when increased production is likely to be felt. France has paid as much as £100 for January shipment. The absence of freight accommodation is being acutely felt.

Average prices of good ordinary brands : December 1915, £82. 4s. 1d. ; November 1915, £85. 6s. 4d. ; December 1914, £27. 6s. 10d. ; average for year 1915, £66. 13s. 8d.

ANTIMONY.—The market for this metal continues in the same restricted state and prices are nominal, say £120 per ton. Chinese crude is quoted at £78 per ton. Our San Francisco correspondent tells of the efforts in the Western States to collect supplies of antimony ore.

QUICKSILVER. — The quotation has receded to £16. 10s.

BISMUTH.—10s. per lb.

COBALT.—8s. per lb.

CADMIUM.—7s. 6d. per lb.

PLATINUM.—The scarcity of supplies has become acute, and the Government has notified all dealers and users to declare their stocks and to place them at disposal if necessary. No quotation is now available ; the last to be given was ten guineas per ounce. Opportunity is being taken to recommend the use of palladium as a substitute, especially in connection with jewelry.

ALUMINIUM.—The market continues within narrow limits, and the nominal price is £200 per ton. In our editorial pages we give an outline of the aluminium position. The American production is likely to be increased during the current year. The Southern Aluminium Company, which was busy before the war erecting works in North Carolina, was controlled by the French Aluminium Company and the American Metal Co., and the war put a stop to the enterprise. It is now announced that the Aluminium Company of America has taken over the venture and will forthwith proceed with the construction of the plant.

NICKEL.—There is no free market for nickel in this country, and the nominal quotation remains at £225 per ton.

CHROMIUM.—Quotations for chrome ore are: New Caledonia 53 to 55%, basis price for 50% Cr_2O_3 £6. 10s., scale 2s. 6d.; Rhodesia 48 to 52%, basis price for 48% Cr_2O_3 £6 5s., scale 2s.; Rhodesia 47%, £6 flat; Baluchistan ore 53 to 55%, basis price for 50% Cr_2O_3, £6. 10s., scale 2s. 6d. Ferro-chrome 8 to 10% carbon, £32. 10s. per ton, basis 60%, scale 10s. per unit.

VANADIUM.—Ferro-vanadium, 14s. 6d. per lb. of contained vanadium.

MOLYBDENUM.—The price of molybdenite remains at 105s. per unit, averaging 90% MoS_2. It is stated that new sources of supply may be expected from Eastern Ontario and Burma. Ferro-molybdenum, 65 to 85%, 18s. per lb. of molybdenum contained.

TITANIUM.—Ferro-titanium, 15 to 18% Ti, and 5 to 8% carbon, 6½d. per lb.; 23 to 25% Ti free of carbon, 1s. 9d. per lb.

TUNGSTEN.—The statutory price of wolfram and scheelite remains at 55s. per unit of WO_3. Attention is being turned to the wolfram resources of Spain and Portugal. An article on wolfram occurrences in the Beira province of Portugal appears elsewhere in this issue. Ferro-tungsten, 80 to 90%, low carbon, 5s. 8d. per lb. of tungsten contained. Tungsten metal powder 96 to 98%, 5s. 10d. per lb.

MANGANESE.—The imports of manganese ores from India are increasing, and nearly all of the Indian ores come to this country nowadays, some however also going to Spain and Italy. At one time large amounts were shipped to the United States. Little or no new business has been recorded, so that prices cannot be quoted with precision; 2s. 6d. per unit for 50% Indian ores and 4s. per unit of 50% Brazil ores may be taken as a probable quotation.

IRON.—The prices of iron have continued to advance and the Government has taken steps to steady the market and regularize supplies. A sliding scale of maximum prices for pig iron has been arranged, the Scottish blast-furnaces have been made controlled establishments, and two additional furnaces are being put in commission in the Middlesbrough district. The quotation of No. 3 Middlesbrough pig iron is 78s. 6d., a rise of 6s. during the month. Bessemer pig is 139s., a rise of 9s. Swedish iron ore is nominally quoted at 36s. to 37s. Spanish hematite ore has risen from 35s. to 38s. Quotations of structural steel are: Steel rails £11, ship plates £12 5s., boiler plates £13 5s., angle irons £13 15s.

SILVER.—The Royal Mint reports that during 1915 the number of silver coins issued was 105,231,515 as compared with 92,455,843 during 1914, and 32,296,527 in 1913. These figures give some idea of the large Government demand for silver. It is stated that the Government purchases amounted to 28,000,000 oz. during 1915. France and Russian government buying has also been a feature of the past year's silver market. On the other hand the requirements in the East have been less. The recent rise in the quotation has not been fully maintained, and the price is now about 26¾d. per standard ounce. As regards other uses of silver, the Kodak company records that during 1915 it used 3,000,000 oz. in the preparation of photographic materials.

NITRATE OF SODA.—The shipments during 1915 from Chile totalled 2,175,000 tons, as compared with 2,005,000 tons in 1914 and 2,975,000 tons in 1913. An unduly big rise in prices during the months August to September caused the re-opening of many works, so that prices have eased, and there is a likelihood of the supply becoming greater than the demard. In Germany nitric acid is largely obtained from the air nowadays. It is of interest to note that the British government is using synthetic nitric acid, one of the producers being the Nitrogen Products Company, which makes cyanamide at Odde, Norway. This cyanamide is not now being sold as a fertilizer, but the ammonia produced from it is being converted to nitric acid by the contact process.

PRICES OF CHEMICALS. January 8.

		£	s.	d.
Alum	per ton	10	10	0
Alumina, Sulphate of	,,	15	0	0
Ammonia, Anhydrous	per lb.		1	4
,, 0·880 solution	per ton	29	0	0
,, Chloride of, grey	per cwt.	1	10	0
,, ,, ,, pure	,,	2	15	0
,, Nitrate of	per ton	75	0	0
,, Sulphate of	,,	17	10	0
Arsenic, White	,,	29	0	0
Benzol, 90%	per gal.			11½
Bleaching Powder, 35% Cl.	per ton	16	10	0
Borax	,,	25	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	2	0	0
Copper, Sulphate of	,,	45	0	0
Creosote	per gal.		0	4
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			8½
Hydrofluoric Acid	,,			5
Iodine	,,		13	9
Iron, Sulphate of	per ton	3	5	0
Lead, Acetate of, white	,,	70	0	0
,, Chemical Sheet Metal	,,	35	0	0
,, Nitrate of	,,	67	10	0
,, Oxide of, Litharge	,,	36	0	0
,, White	,,	37	0	0
Magnesite, Calcined	,,	15	0	0
Oxalic Acid	per lb.		1	4
Phosphoric Acid	,,			10
Potassium Bichromate	,,		1	3
,, Carbonate	per ton	155	0	0
,, Chlorate	per lb.		1	5
,, Chloride, 80%	per ton	52	10	0
,, Hydrate (Caustic) 90%	,,	250	0	0
,, Nitrate	,,	48	0	0
,, Permanganate	per lb		4	6
,, Prussiate, Yellow (Ferricyanide)	,,		3	8
,, Sulphate, 90%	per ton	50	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	52	10	0
,, Bicarbonate	,,	6	5	0
,, Carbonate (Soda Ash)	,,	6	10	0
,, ,, (Crystals)	,,	3	0	0
,, Hydrate, 76%	,,	17	10	0
,, Hyposulphite	,,	18	0	0
,, Nitrate, 95%	,,	15	0	0
,, Phosphate	,,	22	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
Sulphur, Roll	,,	12	0	0
Sulphuric Acid, B.O.V.	,,	3	5	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Zinc Chloride, solution 100°T.	,,	30	0	0
Zinc Sulphate	,,	35	0	0

STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3,202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,243,347
June	727,924	27,356	755,280	3,208,224
July	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122
November	753,605	27,408	781,013	3,317,534
December	755,101	26,010	781,111	3,317,949
Year 1915	8,772,919	320,752	9,073,671	38,627,461

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206,809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879

COST AND PROFIT ON THE RAND.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846
May	2,416,966	25 8	17 0	8 6	1,031,220
June	2,346,493	26 1	17 2	8 8	1,017,908
July	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

PRODUCTION OF GOLD IN RHODESIA AND WEST AFRICA.

	Rhodesia.		West Africa.	
	1914	1915	1914	1915
	£	£	£	£
January	249,032	293,133	128,862	143,649
February	259,888	286,879	123,169	144,034
March	273,236	299,686	131,392	153,770
April	295,907	315,541	131,697	149,978
May	290,062	318,898	145,227	142,123
June	306,421	322,473	147,289	135,289
July	320,670	336,565	152,923	140,290
August	316,972	344,493	150,386	139,364
September	309,398	321,085	154,316	135,744
October	337,241	339,967	159,410	141,771
November	311,711	313,160	154,674	122,138
December	309,669	—	147,699	—
Total	3,580,207	3,491,790	1,727,044	1,548,150

PRODUCTION OF GOLD IN WESTERN AUSTRALIA.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1,829	91,872	93,764	398,282
April	1,017	101,592	102,609	435,853
May	2,311	101,359	103,670	440,360
June	1,273	100,036	101,309	430,333
July	555	98,859	99,414	422,271
August	1,079	99,941	101,020	429,103
September	2,019	100,833	102,852	436,885
October	2,346	100,238	102,584	435,747
November	797	99,206	100,003	424,783
December	2,883	96,997	99,860	424,177
Year 1915	17,277	1,192,790	1,210,067	5,140,189

PRODUCTION OF GOLD IN VICTORIA AND QUEENSLAND.

	Victoria.		Queensland.	
	1914	1915	1914	1915
	£	£	£	£
January	98,200	69,900	63,300	43,770
February	177,800	122,300	85,800	85,850
March	157,000	142,800	74,940	98,550
April	133,700	109,300	79,040	97,320
May	151,400	102,900	80,000	130,470
June	180,800	134,200	85,420	90,500
July	161,800	154,800	79,600	88,830
August	111,200	80,300	92,440	93,050
September	163,400	138,900	82,100	79,470
October	114,100	111,700	96,450	91,800
November	118,000	115,300	102,400	77,780
December	176,400		105,800	
Total	1,743,800		1,027,290	

PRODUCTION OF GOLD IN INDIA.

	1913	1914	1915
	£	£	£
January	187,910	193,140	201,255
February	179,981	185,508	195,970
March	189,715	191,853	194,350
April	191,215	189,197	196,747
May	190,607	193,031	199,786
June	189,322	192,224	197,447
July	193,859	195,137	197,056
August	193,998	196,560	197,984
September	191,642	195,843	195,952
October	194,314	198,191	195,531
November	192,606	197,699	192,714
December	201,931	211,911	204,590
Total	2,299,315	2,340,259	2,366,457

DAILY LONDON METAL PRICES in £ per long ton.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard
Dec.	£	£	£	£	£
1	80	99	28¾	98	166¼
2	79⅝	99	28½	96	165¼
3	78⅝	98½	28	89	168¼
6	78⅛	98	28	89	166¼
7	77⅜	98	27¾	85	165¾
8	76½	97½	28	82	166¼
9	77⅛	97½	28	82	167
10	76¾	97½	27¾	78	169
13	76⅛	97½	27¾	80	167
14	76¾	97½	28⅛	85	168½
15	78¾	98	29	85	167¾
16	79¼	98	28¾	88	165
17	80¾	99	28¾	88	167¾
20	83	99½	28⅞	88	168½
21	84⅜	100½	28⅞	87	167½
22	82⅞	101½	28⅞	88	166¼
23	84¼	102	29	88	166¼
28	85⅞	107	29⅜	88	167¾
29	86	108	29¾	89	167½
30	86½	108	30	90	168¼
31	86¼	108	30½	88	168
Jan.					
3	86¾	110	30½	88	171¼
4	87¼	111	31	88	174¼
5	88¾	112	31¼	88	174
6	91	114	32	88	175½
7	87½	114	32½	88	173¾

Imports of Ores and Metals into United Kingdom.
Long tons.

	Nov. 1915	Dec. 1915	Whole Year, 1915
	Tons	Tons	Tons
Copper Ore	2,998	3,921	38,131
,, Matte and Precipitate	2,167	3,888	38,372
,, Metal (unwrought and part wrought)	8,469	16,297	180,368
Copper and Iron Pyrite	70,742	95,225	903,401
Tin Concentrate	1,606	6,041	44,748
,, Metal	2,078	1,969	38,896
Manganese Ore	67,308	39,271	377,324
Lead, Pig and Sheet	23,776	19,508	256,476
Zinc (spelter)	5,040	3,375	74,520
	lb.	lb.	lb.
Quicksilver	32,398	762,958	3,043,434

Stocks of Copper.
Reported by Henry R Merton & Co. Ld. Long tons.

	Oct. 31, 1915	Nov. 30, 1915	Dec. 31, 1915
	Tons	Tons	Tons
Standard Copper in England	17,200	12,694	9,358
Fine Copper in England	1,210	878	1,763
,, ,, Havre	1,925	1,473	1,220
,, ,, Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*
,, ,, Afloat from Chile	1,050	2,400	3,600
,, ,, from Australia	3,500	3,500	4,000
Total Visible Supply	30,008	26,068	25,064
In other European Ports Estimated	500*	500*	500*

* As on July 31, 1914, but presumably present stock nil.

Exports of Copper from United States
Reported by United States Customs.

1914	Long tons	1915	Long tons	1915	Long tons
July	34,145	Jauuary	28,197	July	16,812
August	19,676	February	12,066	August	16,289
September	23,866	March	29,725	September	14,327
October	28,995	April	20,481	October	26,153
November	20,170	May	25,785	November	19,396
December	16,830	June	15,751	December	32,936
Total 1914	375,101			Total 1915	257,915

Stocks of Tin.
Reported by A. Strauss & Co. Long tons.

	Oct. 31, 1915	Nov. 30, 1915	Dec. 31, 1915
	Tons	Tons	Tons
Straits and Australian, Spot	1,616	1,009	1,042
Ditto, Landing and in Transit	178	560	1,179
Other Standard, Spot and Landing	1,441	1,430	1,682
Straits, Afloat	1,647	2,138	1,077
Australian, Afloat	270	377	301
Banca, on Warrants	—	—	—
Ditto, Afloat	315	875	1,389
Billiton, Spot	—	—	—
Ditto, Afloat	50	—	50
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	2,140*	1,954*	1,719*
Afloat for United States	5,952	7,495	7,195
Stock in America	2,144	1,849	1,371
Total Stock	15,753	17,687	17,005

* Including 715 tons on board enemy's ships either captured or lying in neutral ports.

Shipments and Imports of Tin.
Reported by A. Strauss & Co. Long tons.

	Oct. 1915	Nov. 1915	Dec. 1915	Year 1915
	Tons	Tons	Tons	
Shipments from:				
Straits to U.K.	1,160	1,838	777	23,330
Straits to America	2,050	4,050	3,565	31,565
Straits to Continent	1,231	825	959	11,024
Australia to U.K.	266	298	245	2,481
U.K., Holland, and Continent to America	435	1,030	965	14,967
Imports of China Tin into U.K. and America	215	27	110	3,012
Imports of Bolivian Tin into Europe	498	687	3,380	22,591

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915
	Tons	Tons	Tons	Tons
January	204	466	485	417
February	240	427	469	358
March	247	510	502	418
April	141	430	482	444
May	144	360	480	357
June	121	321	460	373
July	140	357	432	455
August	201	406	228	438
September	196	422	289	442
October	256	480	272	511
November	340	446	283	467
December	310	478	326	—
Total	2,540	5,103	4,708	4,680

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1911	1912	1913	1914	1915
	Tons	Tons	Tons	Tons	Tons
January	3,765	4,022	4,121	4,983	4,395
February	3,163	4,318	3,823	3,555	3,780
March	2,984	3,196	3,562	3,839	3,653
April	3,248	3,904	4,066	4,087	3,619
May	3,742	4,277	4,319	4,135	3,823
June	3,775	3,472	3,993	4,303	4,048
July	3,728	4,234	4,245	4,582	3,544
August	4,083	4,454	4,620	3,591	4,046
September	3,742	4,115	4,379	3,623	3,932
October	4,093	3,905	4,409	3,908	3,797
November	3,948	4,112	3,976	4,085	4,059
December	3.696	4,241	4,614	4,351	—
	43,967	48,250	50,127	49,042	42,696

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January 4, 1915	328¾	£28,353	£86 4 11
January 18	214¼	£18,785	£87 13 8
February 1	215¾	£19,892	£96 13 8
February 15	227½	£21,801	£95 16 7
March 1	218¼	£21,208	£97 3 5
March 15	205½	£20,625	£100 7 3
March 29	224¾	£21,360	£95 0 10
April 12	201	£19,328	£96 3 2
April 26	209	£18,928	£90 11 4
May 10	198½	£18,302	£92 4 1
May 25	180½	£16,473	£91 5 3
June 7	213¾	£19,369	£90 12 4
June 21	188	£17,534	£93 5 4
July 5	202	£18,721	£92 13 5
July 19	204½	£18,102	£88 10 5
August 3	177	£15,069	£85 2 9
August 16	171	£14,098	£82 9 0
August 30	156	£12,935	£82 18 5
September 13	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3
October 11	166	£13,620	£82 1 0
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0
December 20	181½	£16,941	£93 6 10
Total, 1915	5089½	£461,770	£90 14 6

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	Nov. 30 1915	Dec. 31 1915
RAND:			
Bantjes	14	5	8
Brakpan	51	66	68
Central Mining (£12)	160	127	127
Cinderella	6	5	5
City & Suburban (£4)	52	45	42
City Deep	66	69	72
Consolidated Gold Fields	43	29	27
Consolidated Langlaagte	35	38	37
Consolidated Main Reef	18	20	20
Crown Mines (10s.)	120	70	62
D. Roodepoort Deep	17	15	14
East Rand Proprietary	33	23	21
Ferreira Deep	47	40	39
Geduld	23	35	35
Geldenhuis Deep	26	20	20
Gov't Gold Mining Areas	23	28	30
Heriot	55	62	60
Jupiter	5	6	7
Kleinfontein	24	25	27
Knight Central	8	11	15
Knight's Deep	35	30	30
Langlaagte Estates	20	19	19
Luipaard's Vlei	10	8	9
Main Reef West	7	6	6
Meyer & Charlton	115	112	119
Modderfontein B	89	120	117
Modder Deep	58	114	111
Modderfontein, New (£4)	263	305	315
Nourse	27	19	19
Rand Mines (5s.)	120	85	85
Randfontein Central	17	12	10
Robinson (£5)	57	27	26
Robinson Deep	33	23	24
Rose Deep	43	32	32
Simmer & Jack	12	10	9
Simmer Deep	1	3	2
Springs	11	34	37
Van Ryn	67	54	50
Van Ryn Deep	47	58	58
Village Deep	40	36	35
Village Main Reef	40	23	20
Witwatersrand (Knight's)	71	59	57
Witwatersrand Deep	48	30	27
Wolhuter	14	12	11
RHODESIA:			
Cam & Motor	19	14	14
Chartered	17	11	11
Eileen Alannah	11	10	11
Eldorado	18	12	11
Enterprise	9	5	5
Falcon	14	9	9
Giant	14	7	7
Globe & Phœnix (5s.)	32	27	27
Lonely Reef	27	24	25
Shamva	46	40	37
Wanderer (5s.)	3	1	1
Willoughby's (10s.)	7	5	5
OTHERS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	330	232	220
Glynn's Lydenburg	11	9	9
Jagersfontein	78	64	61
Premier Diamond Defer'd (2s. 6d.)	152	97	95
Sheba (5s.)	4	3	2
Transvaal Gold Mining Estates	37	27	25
WEST AFRICA:			
Abbontiakoon (10s.)	8	7	7
Abosso	14	8	9
Ashanti (4s.)	16	18	18
Broomassie (10s.)	2	½	½
Prestea Block A	15	8	8
Taquah	15	15	15
WEST AUSTRALIA:			
Associated Gold Mines	7	6	6
Associated Northern Blocks	7	3	5
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	40	37
Great Boulder Proprietary (2s.)	14	16	15
Great Boulder Perseverance	2	1	1
Great Fingall	9	2	2
Ivanhoe (£5)	50	46	46
Kalgurli	36	16	16
Sons of Gwalia	23	17	15
Yuanmi	3	2	2

* Denomination of shares recently changed from £5 to £10.

GOLD, SILVER, *cont.*	July 1 1914	Nov. 30 1915	Dec. 31 1915
OTHERS IN AUSTRALASIA:			
Blackwater	16	15	15
Consolidated Gold Fields of N.Z.	13	11	11
Mount Boppy	10	10	14
Mount Morgan	52	40	39
Progress	10	5	5
Talisman	33	16	15
Waihi	42	36	35
Waihi Grand Junction	25	20	19
AMERICA:			
Alaska Treadwell (£5)	162	132	147
Buena Tierra	15	14	15
Butters Salvador	20	15	15
Camp Bird	9	8	7
Canadian Mining	—	11	10
Casey Cobalt	13	7	4
El Oro	14	10	9
Esperanza	15	11	11
Kirkland Lake Proprietary	74	15	15
Mexico Mines of El Oro	97	85	80
Oroville Dredging	10	14	13
St. John del Rey	15	16	14
Santa Gertrudis	11	11	9
Tomboy	22	24	23
Tough-Oakes	28	13	12
RUSSIA:			
Lena Goldfields	43	31	29
Orsk Priority	7	8	14
INDIA:			
Champion Reef (2s. 6d.)	11	10	9
Mysore (10s.)	93	80	79
Nundydroog (10s.)	27	26	25
Ooregum (10s.)	23	24	23
COPPER:			
Anaconda (£10)	126	371*	375*
Cape Copper (£2)	60	50	50
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	4	3
Great Cobar (£5)	3	3	2
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	29	29
Kyshtim	55	38	36
Messina (5s.)	15	12	12
Mount Elliott (£5)	55	55	51
Mount Lyell	23	24	24
Rio Tinto (£5)	1355	1120	1130
Sissert	25	20	21
South American Copper (2s.)	22	11	12
Spassky	52	39	37
Tanalyk	78	35	31
Tanganyika	40	28	35
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	28	27	27
British Broken Hill	36	20	22
Broken Hill Proprietary (8s.)	36	47	48
Broken Hill Block 10 (£10)	32	16	19
Broken Hill North	52	43	42
Broken Hill South	175	142	137
Sulphide Corporation (15s.)	26	23	23
Zinc Corporation (10s.)	19	13	13
ASIA:			
Burma Corporation	28	31	32
Irtysh Corporation	—	36	34
Russian Mining	31	15	15
Russo-Asiatic	151	90	91
TIN:			
NIGERIA:			
Bisichi	8	6	6
Jos (5s.)	5	4	4
Kaduna (5s.)	15	15	15
Naraguta	17	12	10
N. Nigeria Bauchi (10s.)	3	2	1
Rayfield	5	4	4
Ropp (4s.)	100	13†	13†
OTHER COUNTRIES:			
Aramayo Francke	31	27	26
Briseis	5	5	5
Cornwall Tailings	17	5	5
Dolcoath	11	6	6
Geevor (10s.)	5	1	—
Gopeng	27	29	29
Mawchi	20	12	14
Pahang Consolidated (5s.)	7	7	7
Renong Dredging	36	25	26
Tekka	55	[illegible]	[illegible]
Tronoh	26	[illegible]	[illegible]

† Denomination of shares recently [illegible]

THE MINING DIGEST

A PRECIS OF MINING TECHNOLOGY, DEVELOPMENT, AND LITERATURE

[*In this department will be found listed the more important articles and miscellaneous publications appearing each month which deal with metal mining and non-ferrous mineralogy, the more significant publications being abstracted or reviewed. Copies of the originals can be obtained through the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.*]

FLOTATION IN THE MIAMI LAWSUIT.

In the course of the presentation of the suit for infringement, brought by Minerals Separation, Ltd., against the Miami Copper Co. before the United States District Court at Wilmington, Delaware, many most interesting facts regarding the history and technology of the process were brought to light. In advance of announcement of the decision, which is expected shortly to be handed down, it would be improper to express any opinion as to the outcome. Indeed it would be impossible to give an authoritative one, since, regardless of the technological features of the case, there are legal principles involved which will doubtless form the basis of the opinion. In general it may be said that precedents may be cited to support the contentions of each party to the suit and that the matter will turn upon which set of precedents is considered more applicable and binding. It is also an open secret that the case will be appealed, so that the first decision may or may not stand. Readers must be warned that both sides introduced evidence not presented in the course of the Hyde case, and it is well known that a court decides only on the basis of the evidence before it. It is thus that contradictory decisions come from co-ordinate courts, and both may be well founded in evidence and law.

Turning to the technology of flotation as presented to the Court, it may be noted that great stress was laid upon the question whether, when the amount of oil used is decreased to "less than one per cent," a different phenomenon occurs, one sufficiently different to constitute invention. Minerals Separation contended that when Higgins decreased the amount of oil, he discovered a radically new process, one in which the particles of air became the lifting force and the "permanent air froth" of "armoured bubbles" was first formed. This "float" was contrasted with skin flotation and bulk oil rafting, the only processes admitted by the complainant to be in the prior art. Miami contended that the prior art also included air bubble flotation. It was shown that several prior patents disclosed the use of amounts of oil much too small to permit of bulk oil rafting, and methods of manipulation such as inevitably introduced air and formed a froth. In this connection the Everson, Froment, Kirby, and certain early patents now belonging to Minerals Separation were cited. It was contended that with only the knowledge disclosed by these it was possible to make workable floats, and that the reduction in the amount of oil to a minimum was but the exercise of the ordinary common-sense of one skilled in the art and hence did not constitute invention. Numerous experiments were performed with various amounts of oil less than necessary for bulk oil rafting and other experiments were cited, in-
* Including 715 tof. three students at the University of
lyin
California, who in 1903 produced floats with as little as 2·1% oil. It was further contended that at Miami the Callow process* involved an important difference from the Minerals Separation processes in suit in that the attachment of the metal-bearing particles to the air "bubbles" was but temporary and separation was effected by producing such a stream of bubbles that they were crowded over the lip of the box before the mineral could be dropped, instead of forming a permanent froth.

In reply to these contentions Minerals Separation held that there was no real prior art save as previously stated, that the patents cited indicated merely a striving for something not attained, and showed failure rather than invention. It was shown, for example, that in the California experiments cited the smaller amounts of oil used gave the poorer extraction, and that after dropping to 2·1% oil the students increased it progressively to 8·9%, thereby improving the extraction and indicating that the line of progress was toward more rather than less oil. Even then the process was only recommended as of possible value with molybdenite and other 'flaky' ores. It was also pointed out that none of these prior art patents attempted to solve the problem of slime, the particular field for present-day flotation. As to the experiments with various amounts of oil performed in Court, it was contended that the extraction was not satisfactory, and that in fact in practice all engineers, including those making the experiments, were using the small amounts of oil specified in the patents in suit. Evidence was presented to show that in various plants when the amount of oil used was increased above the amount cited in the patents, the extraction became so poor that it was necessary to revert to the smaller amounts. This was held to constitute strong proof of the difference in character of phenomenon which constitutes the essence of invention. It was also held that the various experiments presented were performed not with the knowledge and skill of the time of the particular patent, but with that of today and constituted at best the finding in the patents of things not known to their inventors. The attempt was further made to show that with more than the critical amounts of oil a different phenomenon results, an "oil froth" rather than an "air froth" being formed. It was held that in the case of "oil froths" the attachment of the particles was to the oil, and the lifting was essentially "rafting." The raft was made lighter by means of air bubbles beaten into the oil or otherwise introduced; that these bubbles of air were free and by suitable manipulation could be kneeded out when, the mass of oil and mineral being heavier than water, it would sink as in the Cattermole process. In connection with this a most interesting series of

* See p. 48.

moving pictures was presented. In these a captive air bubble was manipulated, the high speed of the original experiment being decreased for purposes of observation. The bubble was shown among other things to have no lifting power for a galena particle in oil, but to pick it up readily both in contaminated and uncontaminated water. When, however, the particle was heavily oiled and placed in water, the bubble pulled the oil out into a long neck but could not lift the same particle. Another oiled particle that could not be lifted by a bubble was carried to the surface when a sufficient number of bubbles, directed in a stream against it, had robbed it of most of its oil. Various other experiments were made to prove that when oil was present in sufficient amounts to cause the mineral particles to adhere—as in the Cattermole process—the air bubbles had no direct lifting power for the mineral particles. In these experiments both particles and bubbles were large, much larger than dealt with in practice, for purposes of observation.

In answer to this the experts for the Miami Company performed in Court numerous experiments in which similar captive air bubbles were made to pick up indifferently both oiled and unoiled particles of flotation size. One such bubble was also made to pick up Cattermole granules, and in other experiments these granules and float were made indifferently under the same conditions, it being indicated that the difference was one of manipulation and not of quantity of oil present. It was held that when excess oil was present it constituted waste, but did not change the essential phenomenon involved since the small amount of oil did its work as usual, and the excess merely filled interstices between the bubbles.

While many other experiments and interesting details were brought out, it seems clear that the principal matters of fact the Court will be called upon to decide are whether there is any essential difference between "oil froths" and "air froths," and what in fact constituted the true prior art at the time of the Minerals Separation invention. Incidentally the trial made especially clear the fact that modern flotation is an air process rather than an oil process. With soluble contaminating agents, cold solutions, and no acid, flotation is still not only possible but with many ores is a greatly improved process.

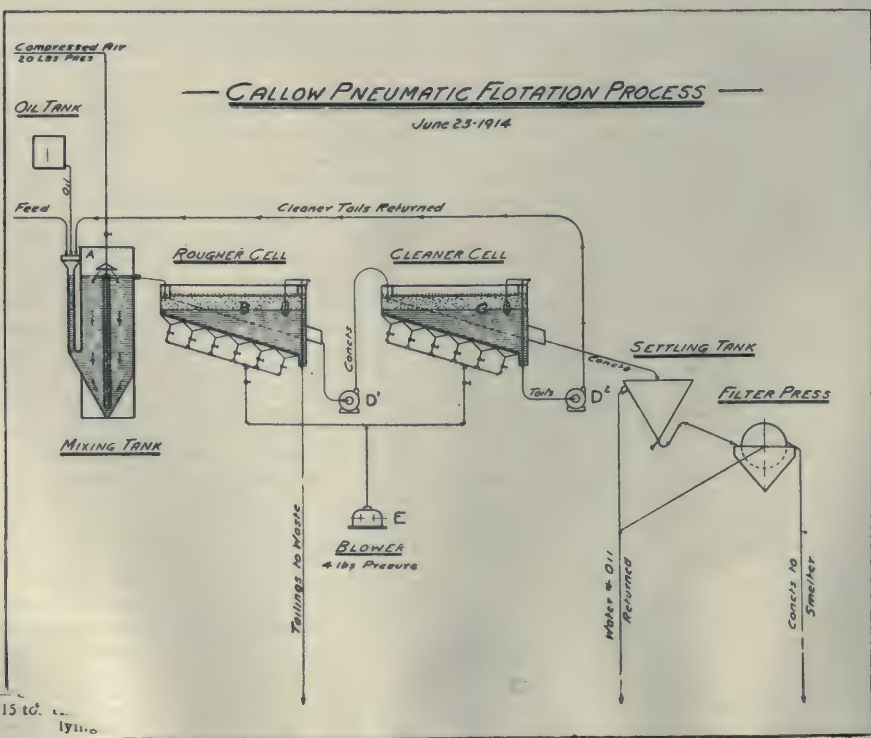
NEW THEORIES OF FLOTATION.

The principal patentees and the metallurgists using flotation in practice have ventured little in public as to the underlying theories of flotation. This is not because the matter has not been investigated, but doubtless is due to the feeling that no wholly satisfactory theory had yet been developed. In the United States the subject has attracted new interest of late. Mr. C. T. Durrell, a practising engineer, proposed in the *Mining and Scientific Press* for September 18, a theory based upon the affinity of 'nascent' gases in the solutions for 'occluded' gases in the particles floated. Stated briefly, he suggests that these two gases meet and collect on the surface of the solid involved until a bubble is formed which is sufficiently large to float the particle. Oliver C. Ralston, of the staff of the Experimental Station maintained at Salt Lake City by the co-operation of the United States Bureau of Mines and the University of Utah, criticizes this theory in the *Mining and Scientific Press* of October 23. He holds it unproved and unnecessary, and states that an adequate working hypothesis can be built up on the known facts and stated either in terms of inter-facial tensions, or in terms of the electrical charges of suspended particles. The first, which goes back to Clerk Maxwell's work, is the more commonly accepted hypothesis. The electrical theory seems to have been developed simultaneously and independently at the Utah Experiment Station, at the Mellen Institute at Pittsburgh, and at the Case School of Applied Science at Cleveland. Mr. Ralston, in the *Mining and Scientific Press* of October 23 last, presents his preliminary results so that other investigators may be able to use them in further research. The work at the Mellen Institute was conducted by R. C. Bacon and J. M. Callow, and Mr. Callow gives a brief statement of the theory in his paper read before the Utah section of the American Institute in October and printed in the December *Bulletin*. At the Case School, where Charles H. Fulton occupies the chair of metallurgy, studies of flotation have been in hand for the last year or more, and in the *Mining and Scientific Press* for November 27 and December 11, Thomas M. Bains, Jr., presents the results. Mr. Callow states the theory briefly as follows: "It is a scientific fact that when a solid particle is suspended in water, the water will form around the particle a contact film which generally possesses an electric charge, the amount and polarity depending upon the nature of the surface of the particle and the electrolyte in which it is suspended. The presence of these charges can be demonstrated by the fact that the particles possessing them will migrate when placed in an electrical field. It has been demonstrated that flotable particles have charges of one polarity (positive) and that non-flotable particles have charges of the opposite polarity (negative); that the froth is charged negatively and so attracts the positively charged or flotable minerals, and repels the negatively charged or non-flotable ones. It is this, it is believed, that causes the flotable minerals, galena, sphalerite, etc., to adhere to the froth, and the gangue minerals, silica, etc., to remain in the liquid where they can be discharged as tailing."

Mr. Bains adds many details and summarizes as follows: 1. Ores containing valuable minerals or metals that are good conductors are the only ones that are suitable for flotation. 2. To buoy these conductors, it is necessary to supply enough electrified bubbles from below to float particles of the conductors that are attracted; hence the smaller the bubble, the better the result, the amount of gas being the same. 3. Some dielectric fluid is necessary to cover the conductor or the bubble, to prevent the dissipation of the electric charge. The thinner the film of dielectric and the greater its dielectric strength, the greater the effective attractive force and the more permanent will be the froth. 4. Some material must be added to the water to increase its conductivity, to obtain a clean concentrate; acids in small quantity are now used. He also suggests that since the electrification of minerals varies with different acids and also with different strengths, preferential flotation can be accomplished as for example in separating blende, galena, pyrite, and quartz as follows: "Add dilute sulphuric acid and pan off the blende; then add dilute nitric acid and pan [illegible]een galena; then add concentrated sulphuri[illegible] tons per acid, which attacks the pyrite so it[illegible]Co.'s plant will off." The same result may [illegible] sand from previous "nitric acid above, varying the strengths; with sulphuric acid, by use of a 'robbing' action; or by use of hydrochloric and other reagents that attack one or another of the minerals more strongly than another." He makes another statement that, if the electric theory be accepted, has a bearing on the disputed question whether in flotation the phenomenon as essentially different when the oil or frothing agent is reduced to the extremely small amounts specified in Minerals Separation patents. It is that "the sulphides are positively charged by friction, while the frothing agent and air are charged negatively. The oil surrounds the sulphides, but the film is so thin that the negatively charged bubble is attracted by the positively charged sulphide. If the film of oil is too thick, the attraction between the sulphide and bubble is too feeble, and flotation fails." Mr. Ralston considers that "the inter-facial tension and the charge on the inter-facial film are two different physical properties of one and the same thing," and states that "No one can claim that electrical charges carry the whole explanation of flotation, nor can it be stated that it is merely a balancing of inter-facial tensions." The importance of his work, which extends also to settlement of slimes and similar phenomena, is that it presents at least strong probability that the laws of colloidal chemistry are applicable to ore slimes or "coarse suspension colloids" as he calls them. If indeed the analogy be sufficiently close, even if it be nothing more, progress in flotation may be immensely accelerated by carrying over into this field what is now known of colloids and electrostatics.

CALLOW'S FLOTATION METHOD.

In August 1914 we gave an outline of the flotation method introduced by J. M. Callow in the Cœur d'Alene lead-zinc region of Idaho. This method has proved successful at many mines in that district, including the Bunker Hill & Sullivan. Since that date it has been adopted for the treatment of copper ores, notably by the Inspiration, the Anaconda, and Arizona Copper companies. Mr. Callow contributed a paper describing his process to the American Institute of Mining Engineers, and it was published in the December *Bulletin*. Put briefly, the method consists of introducing oil and air into the pulp in a vessel similar to a Brown agitator or Pachuca vat, and passing the mixture or emulsion thus obtained into cells having perforated bottoms through which air is forced upward. The compressed air, as it rises, creates the flotation froth. The first set of cells are the 'roughers,' in which a crude concentrate is produced. This is afterward sent to 'cleaner' cells, where a final concentrate is obtained. After settlement, the concentrate is sent to filter presses to be dewatered. The accompanying illustration gives an outline of the arrangements. The dimensions of the cell are about 9 ft. long, and 2 ft. wide, with a bottom inclined at 3 to 4 in. to the foot, the depth being 20 in. at the front end and 45 in. at the deeper end. The structure is preferably of wood. The bottom consists of a porous medium made of four thicknesses of loosely woven canvas twill, supported by a backing of perforated metal. Through this porous medium compressed air is forced. The space under-



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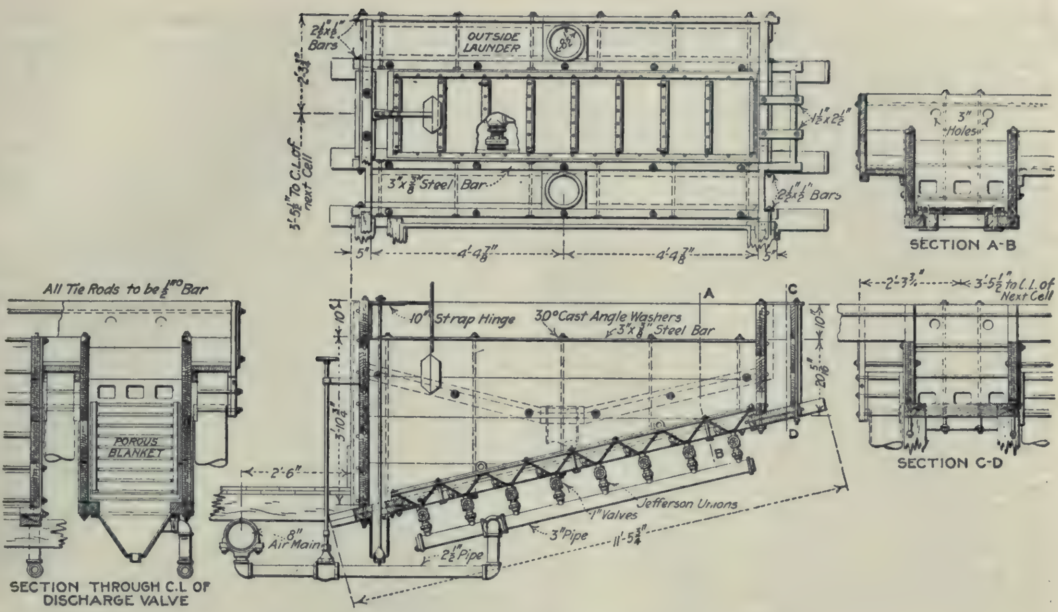


WORKING DRAWING OF THE CALLOW FLOTATION CELL.

neath the porous medium is subdivided into eight compartments, each connected by an individual pipe and valve with the main air-pipe. By this means the air pressure to each compartment can be regulated, by throttling the valve, to correspond to the varying hydraulic head within the tank, and so as to discharge a uniform amount of air throughout the length of the bottom and maintain a uniform aeration of the contents. A pressure of from 4 to 5 lb. is generally used, each square foot of porous medium requiring from 8 to 10 cu. ft. of free air per minute. Each longitudinal edge of the tank is provided with a lip and an overflow gutter for the reception of the froth to be discharged. The lower end of the tank has a spigot discharge fitted with a plug valve, operated by a float, to maintain a uniform water-level within the tank and thus, in turn, maintain a uniform and constant discharge of froth under all the varying conditions of feed supply. The water-level may be varied, but it is usually maintained at about 10 to 12 in. below the level of the overflow lips. The tailing is discharged through the spigot, and the frothy concentrate is conveyed by means of side gutters to a pump and thence to the cleaner cell. This cleaner cell is a machine of the same construction as the rougher. In operation, however, it is usually run with a lower air pressure than that used on the rougher. The tailing from the cleaner is returned by a pump to the original feed, a closed circuit thus being maintained on this portion of the feed. Usually one cleaner serves four roughers. The machines may be run either in parallel or in series without any sacrifice in the capacity for a given number of cells. Recent experience goes to show that on some ores the series treatment gives a slightly cleaner tailing. It is not necessary to extend this arrangement of cells beyond two cells in series. In a heavily mineralized ore this arrangement is decidedly advantageous, and in such a case the rougher concentrate might be of high enough grade to dispense with the re-cleaning operation. The froth from the second cell in the series might be returned to the original feed in the same way that the tailing is returned from the cleaner when practicing a roughing and cleaning operation. A number of such combinations are possible.

The froth is generated as the result of injecting the finely divided air into the bottom of the already emulsified pulp; it continues to form and to overflow so long as it is furnished with pulp of the proper consistency, adequately mixed with the right quantity and kind of oil or frothing agent. Measured from the water-level within the cell, the froth produced may be from 14 to 16 in. thick and will be more or less voluminous, coarse or fine-grained, dry or watery, according to the character of the ore and the kind and quantity of oil introduced. The condition of the froth may be varied by changes in the kind and quantity of oil used, and the quantity of air injected. The pulp to be treated may be of varying density, from 2½ of water to 1 of ore, up to 5 or 6 to 1. For a mixture of sand and slime, the former ratio is preferable, but for a pure slime mixture (minus 200 mesh) the larger proportion of water is allowable. The particular density is not a matter of as much importance as the supplying of pulp of uniform density, as each variation in the density of the pulp requires a readjustment of the oil supply, the quantity of oil increasing in proportion to the increased volume of the pulp, independent of its solid contents.

A normal capacity of the roughing cell is 50 tons per 24 hours. This, of course, will vary according to the nature of the ore. In one plant which practices gravitation previous to flotation, only the fine sand and slime being treated, the rate is 50 tons per roughing cell. The Inspiration Copper Co. practices flotation as the prime process, each 800-ton section employing 24 roughing cells and four cleaners. The cells in this case are run in series, the primary cells treating the original feed and the secondary cells treating only the slime from the primary tailing after the sand has been removed. This gives an average of 33·3 tons per roughing cell. The Arizona Copper Co.'s plant will treat the slime and re-crushed sand from previous gravity treatment; out of an original tonnage of 4000 about 3600 tons will be treated by flotation. This will be handled in 63 roughers run in parallel, and 18 cleaners, or an average of approximately 57 tons per roughing cell, or 45 tons per cell for roughing and cleaning. Some tests have shown little difference in recovery when running from 45 tons to the cell or 65, but show that the recoveries commence to decline as soon as the tonnage exceeds 75 tons. In the Coeur d'Alene, on zinc-lead ores, 35 tons per cell is an average capacity.

The oils used may be broadly divided into 'frothers' and 'collectors.' The pine oils are good frothers, and coal tar and its various subdivisions are good collectors. On some ores, crude pine tar will in itself combine the properties both of frothing and collecting; on others, this may have to be enriched by the addition of some one of its more volatile constituents, such as refined pine oil, turpentine, or wood creosote. Generally speaking, the coal-tar products are poor frothers, and to get a sufficient volume of froth to insure a high recovery it is often necessary to add refined or crude pine oil, creosote, etc. At the Inspiration mill, for instance, the mixture is 80% crude coal tar, 20% coal-tar creosote; at another plant on similar ore 45% El Paso coal tar, 40% coal-tar creosote, 10% cresol, and 5% pine oil. At Daly-Judge a mixture of 40% crude coal tar, 40% creosote, and 20% pine oil was used. In the Coeur d'Alene on zinc ore, straight wood creosote was used; on the ore of the National Copper Mining Co., plain turpentine will work, but pine oil is better. At Inspiration, from 1½ to 2 lb. of the mixture per ton of ore was used; at Daly-Judge, 1 to 1½ lb.; and at the National 0·3 lb. of oil is sufficient. In the experimental work at another plant the oil consumption was approximately 1 lb. of mixture per ton; but since the entire plant has been in operation, and the circuit water reclaimed and used over again, the oil consumption has dropped to 0·35 lb. At present the proper kind or kinds of oil and the requisite quantity can only be determined by experiment; no scientific way has thus far been found.

The froth made by the Callow process has the distinctive characteristic of being unstable or ephemeral; that is, it quickly dies when removed from the action of the injected air. The bubbles composing the froth are generated under a hydraulic pressure varying from 15 to 40 in.; upon rising above the water to the froth level, the bubbles burst by reason of the lower pressure of the atmosphere. On bursting, they release the mineral attached to them, which is caught up by the bubbles following immediately behind. The stability of the bubbles depends to some extent upon the oil used and the nature of the gangue in the pulp treated. Pine oil makes a brittle froth which dies immediately on arriving at the surface. Creosote and light oil make a more elastic envelope, which at times will expand into bubbles 3 to 4 in. in diameter before bursting. Pine-oil bubbles are rarely over ¼ or ½ in. in diameter. Castor oil, olive oil, candle-makers' oil (oleic acid), palm oil, sperm oil, and other oils of a lubricating nature, have in general been replaced by oils more or less soluble or miscible in water, such as turpentine, pine oil, and all the coal and wood tar distillations. The extremely volatile oils such as naphtha, petrol, ether, and alcohol, seem to be of little use except as means for making the pitchy ingredients of coal and wood tars more soluble or miscible. A large, coarse, and elastic bubble seems necessary to the recovery of coarse-grained mineral, but for the very fine and colloidal mineral, a small and comparatively brittle bubble is necessary.

CYANIDE TREATMENT OF FLOTATION CONCENTRATE.

Extensive application of cyanidation to silicious ores some years since upset the balance at the smelters and checked the decrease in rates on sulphide ores. This in turn caused the cyaniders to search for methods, which proved widely applicable, of local treatment of concentrates. Flotation is now bringing in a new and large supply of concentrates, and it is a serious question how far cyanidation can be applied. This matter has been under study in the Butters laboratory and in the *Mining and Scientific Press* for November 20, Charles Butters and J. E. Clennell present results of work on flotation concentrate from the San Sebastian mine in Salvador.

"The difficulties attending the treatment of concentrate by cyanide," say these authors, "are well known. The process of concentration collects in a small bulk not only the valuable constituents of the ore but also those substances that act as cyanicides, or which are readily converted by oxidation or otherwise into cyanicides, so that their influence, per ton of material treated, is greater than would be the case with the unconcentrated ore. Heavy minerals such as the sulphides of iron, copper, lead, arsenic, antimony, zinc, and double sulphides such as mispickel, proustite, pyrargyrite, and bornite, naturally tend to accumulate in the concentrate. If some interval elapses between the formation of this concentrate and its treatment, oxidation may take place, with formation of sulphates, arseniates, and antimoniates, which are still more detrimental to cyanide treatment than the original minerals. These difficulties have been wholly or partly overcome by the adoption of modifications in the treatment, such as preliminary water, acid, or alkali washing, roasting, fine grinding, the use of special solvents, such as bromo-cyanide, and prolonged contact of the material with cyanide, extending in some cases to over a month.

"In the case of concentrate produced by flotation, the minerals composing the product are substantially the same as those obtained by gravity concentration, consisting of the sulphides and double sulphides of the heavy metals, and it is to be expected that the same difficulties will be encountered in their treatment. But as the concentrate also contains a considerable part of the oil, tar, or other flotation agent, the presence of this foreign matter must be taken into account. In some cases, this circumstance introduces an additional difficulty. A part of this organic matter is soluble in the cyanide or alkali used in the process, and the solution so formed may be capable of absorbing oxygen. The effect produced by carbonaceous matter in precipitating gold and silver previously dissolved by cyanide is well known and has been a source of much trouble in many localities. Some of the constituents of this matter are not easily eliminated and appear to resist oxidation even at a high temperature; roasting under ordinary conditions does not completely remove the carbon; it is probable that a portion derived from tar remains in the graphitic form, capable of acting as a precipitant for gold or silver."

Elaborate tables are presented showing the effect of various modifications of direct treatment as applied to the San Sebastian concentrate. It was found that an extraction of 98% could be obtained from the flotation concentrate after roasting, water washing to leach out the sulphates, and cyaniding. Cyaniding the raw ore proved unsatisfactory.

PYRITE SMELTING AT MOUNT LYELL.

At the 1915 meeting of the Australasian Institute of Mining Engineers, held at Queenstown, Mount Lyell, Tasmania, the President, Robert E. Sticht, devoted his address to pyritic smelting practice at Mount Lyell, a subject on which he is the unrivalled authority. His address dealt with the details of present practice and not with the chemical theory. It is a long address, covering 50 pages of the Transactions, and it constitutes an important contribution to metallurgical records. As we quoted a lecture on the subject delivered by Mr. Sticht during his recent tour in America, in our issue of February last year, we need not give on this occasion the history of the development of the pyrite smelting method, nor the outline of the theory. We have only space here to mention one or two of Mr. Sticht's points. Pyrite smelting may be said to partake of the nature of continuous bessemerizing, the blast under high pressure being adapted to making a slag of the iron and silica by the heat of combustion of the iron and sulphur. While the air pressure in pyrite smelting tends to approach that in bessemerizing, the volume of air must be far greater in pyrite smelting on account of the greater proportion of iron and sulphur to be oxidized and scorified in comparison with the copper to be saved. In the early days the blast was heated, but later the process was made to work equally well with cold blast. The cost of heating the blast was considerable, and greatly exceeded that of the additional coke added to the charge when cold blast is used. The amount of coke employed averages 0·1%. Both the pyrite of the Mount Lyell mine and the silicious ore of the North Lyell are physically ideal, both of them breaking into lumps that are exactly adapted for the blast-furnace. The charge is porous to the blast, and the constituents are mixed so as to avoid layers. There are no separate oxidation and slag-forming zones. The even distribution of the free silica in the charge is of prime importance. The silica may be called the 'skeleton' of the charge, with silica cells enclosing pyrite; thus the whole column consists of an aggregation of miniature bessemerizing vessels with silicious walls. Mr. Sticht proceeded to describe the chemical reactions as the charge falls, and afterward he discussed the constitution of the charge. His remarks also covered the continuity of action, and the stopping and starting of operations. His account of the method of feeding draws attention to the importance of correct practice in a detail often neglected, and we accordingly quote his remarks at length.

It is now generally conceded that the manner in which the modern copper blast-furnace is fed, by simply sliding the charge into it *en masse* over an inclined plane on the long wall, is too crude to do justice to the requirements of good smelting. It certainly shows itself to be a mistake in pyrite smelting, and the mechanical features, which make it attractive to the metallurgist who is bent on saving the small labour attaching to the actual feeding, are blinding him to the troubles and costs which the bad feeding entails, and which are not so obvious. It is quite possible to deliver the materials to the furnace by the same means, the electric train, in both cases, but they should not be dumped in helter-skelter. Whatever may be the case with ordinary blast-furnaces, it is a fact that pyrite furnaces, on which this careless method of charging is used, are not doing good or really economical work, as is evidenced by their low-grade mattes and short campaigns. It is impossible, in the first place, under the conditions of wholesale delivery, as mostly arranged nowadays, to do close work, such as running each furnace individually, and the result is that the nest of furnaces is run as one unit. This obliges the metallurgist to average the composition of the charges practically down to the mean requirements of the nest, and to forfeit the advantage of the superior work which can be done by the furnaces which are in better trim. Those which are not in good trim cannot, of course, be forced to do good work, and a mediocre standard, embracing all the furnaces in the nest, is the only recourse. Dump feeding, whether from the side or from the top, treats the operation as if it had to be finished as quickly as possible, and as if the amount of care required were negligible. Experience at Mount Lyell proves that this is not so. The feeding at Mount Lyell is done on each long side of the furnace, off a horizontal charging plate, which reaches into the shaft with a slight overhang. On to this plate the charge constituents are tipped, out of end-discharging handcarts, in a narrow pile, as long as the opening and parallel to the furnace, so that, when pushed over the edge of the plate, the materials drop so as to cover one-half of the top of the column on each side. The materials drop gently over the edge of plate, and do not shoot across to the other wall and rebound. A special device is used for pushing the substances in, which consists of a line of hinged steel plates, inclined forward and parallel to the furnace, which is fixed to a frame embracing both sides of the furnace, and is actuated by means of a hydraulic cylinder. The movement is to and fro, the two sides of the furnace being fed alternately. The pusher plates ride freely, on the return stroke, over any matter left on the charging plates, but the latter are swept quite clean on the forward movement. The charge constituents are not delivered mixed together, but singly, one after the other, and are pushed in separately.

This device has simplified and perfected the feeding. It is possible to do with it all that can be done by hand feeding, and, when particular places on top of the column have to be specially humoured, the feeder still can do so by hand, if he likes, with the long-handled shovel, using the blade inverted. The distinction between coarse and fines can be maintained as with hand feeding, the respective material being directed to be dumped by the wheeler in front of the right spot; or the separation can be done by the feeder on the plate, with a few strokes of the shovel in the long heap, before pushing. The placing of the materials on to the charging plates is under the immediate direction of the feeder, and he is held responsible for the condition of the throat. If the throat is properly nursed, the rest of the ore column in action will take care of itself. A good deal depends upon the placing of the coarse or fines at the proper place on top of the charge, and in connection therewith the proper overhang of the charging plate is of some moment. Notwithstanding that all materials fall almost vertically off the edge, the fines fall closer to the wall than the lumps, and the exact place where the latter assemble depends upon the vertical distance from the charging edge to the top of the column. The furnace can be fed with a gullet down the centre line, or with a hillock along that line, or with more than one gullet or furrow. The overhang distance has an effect on these points, and a device has been worked out permitting of instantaneously changing the amount of the overhang, but it is not really being used.

Ordinarily speaking, for normal running the practice is to distribute the materials evenly over the full top of the column. The latter is not visible from the charge openings, as these are made only high enough to allow the charge to be pushed in (14 in. by 18 ft. 6 in.), so that the indraught of air and the back-leak of fumes may both be minimized. There are no doors on the charge openings. The feeder observes the state of affairs at the throat through a lidded opening in the swinging doors at each end of the superstructure. The barring of the furnace throat is done through these doors only. The gases must be seen issuing evenly from all over the top of the column, with only slightly more coming up along the walls. The pieces of charge, of course, remain black on the top of the column for some time after charging, and those of the underlying layer show a dull red heat. There is no appearance of high incandescence. A perfectly black top would soon lead to the formation of crusts. The general temperature right over the top should not be much higher than suffices to ignite the subliming sulphur, and the top must be kept down to bring this about, but not much lower than this, if possible. There should be no blow-holes. Dead, glowing red places are indicative of the formation of accretions, or wall crusts, and are not permitted to grow too much. They would eventually close the furnace throat, and, in any case, they upset the distribution of the blast. They are attended to at once by feeding some of the pyrite on to them, and keeping the silica off. If accretions have formed all along the walls, then most of the feeding is done along the centre line of the throat. When the throat is working properly there is a constant crackling noise from the decrepitating of the pyrite, etc.

Smelting Stannite Ore.—At the 1915 meeting of the Australasian Institute of Mining Engineers, held at Mount Lyell, Tasmania, J. H. Levings read a paper describing the metallurgical campaign at the Oonah mine, Zeehan, where stannite ore was treated in a blast-furnace. The mine belonged to an English company, and we quoted its report in our issue of February 1910, when an outline of the practice was given by the consulting engineers. Mr. Levings enters into greater detail, and though the venture did not prove commercially successful, the record is of some interest. Stannite is a complex sulphide of tin, copper, and iron, and is often known as tin pyrite. At Oonah the stannite vein occurs in a graphitic slate, and is proved to be older than the galena lodes which are numerous in the Zeehan district. On the surface the ore was rich, and many shipments were made, averaging 20% copper, 18% tin, and 150 oz. silver per ton. Other constituents of the ore were bismuth and arsenic. The first treatment method was by reverberatory furnace, with a blast-furnace to smelt the reverberatory slag. When the reverberatory practice proved unsuccessful, semi-pyrite smelting was commenced in the blast-furnace. This blast-furnace had been built high, the distance from the tuyeres to the feed floor being 25 ft., so that opportunity was given for experimenting as to the best height for the column of ore. The process was successful from the start, a charge concentration of 15 into 1 being obtained, with a coke consumption of 4%. A height of charge of 13 ft. was found to give the best results with the blast obtainable. The high shaft was also found to be of service when the furnace became crusted on top, and the blast was hissing through blow holes, with a scanty fall of high-grade matte below. Then the coke on the charge was increased to 8 or 10%, and the furnace rapidly filled up 3 or 4 ft. In the course of some hours the scaffold would smelt out and the charge fall bodily 2 or 3 ft. The furnace would then be quite free and in good condition. By promptly cutting the coke again to 4%, and lowering the stock line, the matte would average normal right through the operation. By this procedure a campaign might have been continued indefinitely, if it had not been for the brickwork of the walls above the jackets burning out. Every stoppage was occasioned by this cause, and the longest campaign was three months.

In the pyrite smelting about 50% of the tin was volatilized, the remainder mostly going into the slag, and the balance into the matte. The silver recovery was fairly good. It became imperative, however, to save the tin. In smelting the reverberatory slags for this metal, it was found necessary to make a low-grade matte in order to keep the crucible of the blast-furnace open, the matte, however, not interfering with the tin-recovery beyond retaining the tin, as sulphide, which had been present as pyrite before smelting. Nevertheless, a scheme was outlined to blast-roast the ore, with 15% added iron-manganese oxides, down to 8 or 9% sulphur, and then smelt in the blast-furnace under severely reducing conditions. With this practice, the products were a 20% copper matte, containing 42 oz. silver per ton, and a copper-tin alloy, containing 660 oz. silver per ton, 42% copper, 40% tin, the balance being made up of lead (from the ironstone flux), bismuth, antimony, arsenic, and a little iron. The tin and copper approached the proportions in stannite, $SnCu_2$. The alloy was tin-white in colour, notwithstanding its high copper content. The iron content rapidly oxidized, giving the alloy a rusty appearance on the exterior. For this alloy, with a tin-copper-silver value of £200 per ton, no purchaser could be found in Australia. Afterward it was sold in England for £80 per ton.

On the termination of this campaign the furnace was put back on pyrite smelting, but the ore reserves were soon exhausted. The owners did not feel inclined to furnish the capital to put in the necessary new machinery to sink the shaft and open up the mine, so that nothing further was attempted.

From the experience gained Mr. Levings propounded in his paper a treatment process which he has not had the opportunity to put into practice. It may be of interest to some metallurgist, so we quote it herewith. In the blast-roasting of the stannite no volatilization loss of tin could be detected, although the pots were blown as briskly as possible. In the pyrite smelting, quantities of a greyish sublimate readily formed on the sides of the cupola, and, had the furnace been provided with dust-chambers, a quantitative amount could have been collected. On investigation it proved to be nearly pure tin oxide. This suggested a method for separating the tin from the silver and copper, and laboratory experiments carried out on these lines were satisfactory. Reasoning from the collected data, the following scheme was outlined: (1) A preliminary roast in mechanical furnaces, in part, or wholly, of the stannite ore, to be followed by blast roasting; (2) Smelting of the roasted product under reducing conditions, producing tin-copper alloy, and sufficient 30% matte for the next operation; (3) Blowing the alloy and matte in the usual copper converter into silver-copper bullion and volatilized tin oxide, the latter to be collected in flue-chambers, which should be sufficient without a bag-house; (4) Reduction of the tin oxide in a reverberatory or disposal to a tin smelter.

Bauxite.—The scarcity of aluminium due to war requirements has aroused inquiries among users with regard to the sources of the metal and the possible extension of its production. In early days the metal was obtained by reaction with metallic sodium, but for the last 25 years it has been produced by the electrolysis of alumina in a bath of fused cryolite, the double fluoride of sodium and aluminium, using carbon anodes which are consumed in the process. This method was invented contemporaneously by Hall in the United States and by Heroult in France. The present interest in aluminium renders it appropriate to quote an article on bauxite appearing in *Engineering* for December 17. Bauxite is hydrated oxide of aluminium associated with varying amounts of ferric oxide, and the ore generally contains silica and sometimes titanium oxide. The ore usually occurs with other aluminium compounds such as kaolin and common clay. It varies in colour from white and yellow to red and brown, its lustre is earthy, fracture uneven, hardness 1 and occasionally more, and specific gravity 2·5. Bauxite occurs in various forms, either in rock form like syenite, pisolitic, or oolitic, or as clay. The pisolitic form is usually called gravel ore and can be worked with pick and shovel. Besides being the ore of aluminium, it is used for making alum salts, the manufacture of refractory bricks for kilns and furnaces, and the production of the abrasive, alundum. The refractory bricks are used for lining cement kilns, basic open-hearth steel furnaces, and lead-refining furnaces. Alundum is formed in the electric furnace by the treatment of bauxite high in iron and is virtually artificial emery. During the last few years bauxite bricks have been used in lead-refining furnaces, as they withstand the attacks of the slag, which consists chiefly of oxides of lead and other metals, much better than ordinary fire-bricks.

Bauxite is found extensively in the south of France, in County Antrim, Ireland, in Carinthia, Austria, in Hungary, and in Calabria, Italy, while deposits are known in India and New South Wales. Extensive deposits have been proved in the United States, especially Arkansas. The yearly output of bauxite in France is about 300,000 tons, the United States 220,000 tons, Ireland 8000 tons, Italy 6000 tons. The Irish bauxite averages 45 to 55% alumina, 23 to 30% water, 5 to 20% iron oxide, 8 to 16% silica, 4 to 7% titanium oxide, and less than 1% lime. The German bauxite is used chiefly for the production of refractory bricks.

Stone Dust.—The Explosions in Mines Committee has issued a seventh report, containing the result of Dr. J. S. Haldane's investigations into the possible evil effects of stone-dusting in collieries. As we recorded in our issue of November 1914, the Committee has already accepted Sir W. E. Garforth's contention that a mixture of equal parts of stone dust and coal dust is not explosive, and has accordingly recommended the dusting of colliery workings on this principle. Before finally closing the subject, the Committee instructed Dr. J. S. Haldane to make investigations as to whether the health of the miners would suffer. Dr. Haldane's report confirms the fact that the dust of clay-shale has no deleterious effect on the miners' health, no symptoms of tuberculosis or fibrosis of the lungs being directly attributable to it, though the dust of silicious rock is deadly. It is desirable that clay-shales shall be chosen that contain the least amount of silicious grit, and that the grinding of such shale for dusting purposes shall not be so fine as to break the particles of silica. The natural worn surfaces of the silica do not have a bad effect on the lungs, and it is only when sharp clean edges are produced by fracture that the evil effect arises. The action of silica contained in certain varieties of igneous rock is puzzling, for the dust generated by drilling and blasting at some mines where the igneous rock contains as much as 70% free silica does not appear to have any deleterious effect on the lungs. Dr. Haldane instances the case of the mines in the Cripple Creek district, where dust of igneous rocks does not cause phthisis. Further researches as to the effect of silicious dust on the lungs appears to be required.

Clay in Ore-Dressing and Cyaniding.—At the December meeting of the Institution of Mining and Metallurgy, a paper was presented by A. W. Allen containing a record of all information and theories relating to the effect of colloidal clay on ore-dressing and cyaniding operations. He discusses the phenomena of absorption and adsorption, as applied to the explanation of the impossibility of removing gold solution from clayey slime; he inquires into the causes that make weathered clay slime more difficult to treat than freshly mined material, and into the reasons why milling a clayey ore in cyanide solution does not give such satisfactory results as when the milling is done in alkaline water. His general conclusions are that the main losses of gold are due to absorption and not adsorption. Mr. Allen's bibliography and discussion of the views of various writers make his paper valuable.

Lungwitz Zinc-Smelting Process.—At the October meeting of the Mining and Metallurgical Society of America held in New York, W. McA. Johnson recounted the unsuccessful attempts of 10 years ago at smelting zinc ores in a blast-furnace, according to the patents of Emil Lungwitz. The process consisted in conducting the smelting operations at such a pressure that the zinc vapour would be liquified. A blast-furnace was erected at Warren, New Hampshire, and the work was in the hands of F. C. Gordon, a distinguished Alabama iron metallurgist. The pressure of the blast was 60 lb., afterward raised to 80 lb. The experiment was, however, a failure, no zinc was obtained, and the plant was abandoned. Mr. Johnson contributed these notes for the reason that records of failure are often helpful.

Leaching Low-Grade Oxidized Lead Ores.—The United States Bureau of Mines reports that the department of metallurgical research of the University of Utah is testing a process for leaching low-grade oxidized lead ores. These ores are at the present time being neglected by the various lead mines, though the corresponding sulphur ores of equally low grade are profitably worked. The process is based on the solubility of lead sulphate in saturated brine. The ore is leached with brine containing sufficient sulphuric acid to convert the lead carbonate to sulphate, and the resulting solution containing 1½% lead is electrolyzed with the production of spongy lead. Iron anodes and either iron or lead-coated iron cathodes are used. In Utah the resources as regards brine and salt are great. Instead of electrolytically precipitating the lead, it may be recovered by means of milk of lime.

Warming Cyanide Solutions.—At the December meeting of the Institution of Mining and Metallurgy, E. A. Wraight presented a paper describing experiments made with the object of ascertaining whether the rate of dissolution of gold by means of cyanide could be increased by warming the solution. The published records of similar investigations are limited, and the results obtained are either vaguely interpreted, or attributable to other causes. Mr. Wraight first undertook a series of researches in which the pulp was agitated and heated by steam. His general results showed that though rather more gold was dissolved during the first hour by hot solution, the efficiencies of the hot and cold solutions were much the same afterward. His individual results were naturally governed by the nature of the particular ores treated. He subsequently conducted another series of experiments in which the agitation was effected by means of hot air. In this case he obtained striking results, for the rate of dissolution of the gold was substantially increased. His conclusion is that the oxygen effect in the cyanide reaction is increased when the oxygen is heated.

Preventing Corrosion of Metals.—Any method whereby the use of zinc is avoided in these days of special demand is of interest. We therefore make note of Elliott Cumberland's paper read at the last meeting of the Faraday Society, describing his process for preventing corrosion in steam boilers and condensers. Corrosion is caused by electrolytic action. In brass tubes, wherever the zinc is segregated, electric couples are set up when in contact with water, and as the zinc is electro-positive to the copper it is attacked, with the result that the tubes rapidly deteriorate. The cure for this state of things is to see that the metals in the brass are not segregated. A more prolific source of corrosion is that of the iron of the boiler shell, for iron is also electro-positive to copper. To protect the iron, it has been the practice to fasten zinc plates to the internal surface, and the current then passes between the zinc and the copper, corroding the zinc. The action is not effective for long, and the zinc plates must be renewed at regular periods. The apparatus introduced by Mr. Cumberland has for its object the elimination of the use of zinc, and the substitution therefor of a weak counter-electric current. This is done by suspending insulated iron plates in the water and passing a current from a dynamo from them to the iron of the shell. The method has the additional advantage of preventing the deposition of scale on the iron surfaces.

TECHNICAL JOURNALS FOR THE MONTH

British.

Association of Mining Electrical Engineers.—*December:* Some Causes of Failure in Electrical Power Plant for Mines, T. Anderson.

Colliery Guardian.—*December 17:* Diamond Coal-cutting and Conveying Machines, T. Campbell Futers. *December 31:* Hardy Patent Pick Co.'s 'Hardiax' Coal Cutter, T. Campbell Futers. *January 7:* The Underground Fire at Griff Clara Colliery, Warwickshire, F. Povey Harper; The British Coal Trade during 1915.

The Engineer.—*December 17:* Part 5 of series of articles on the Water Powers of Canada. *December 24:* Experimental Plant for Production of Oil from Coal.

Engineering.—*December 24 and 31:* Electric Railway for the Riksgrausen Iron Mines, Swedish Lapland. *December 31:* New Hydro-electric Power Plants in Norway for Aluminium, Carbide, etc., production. *January 7 and 14:* The Lake Margaret Hydro-electric Power Plant for the Mount Lyell Mining & Railway Co., Tasmania. *January 7:* The Life of Concrete Structures.

Faraday Society.—*December 8:* Electrolytic Process for Preventing Corrosion in Boilers, obviating Use of Zinc, E. Cumberland; the Corrosion of Steel Alloys, Sir R. A. Hadfield.

Geological Society.—*December 15:* Particulars of Bore for Coal in Buckinghamshire, Aubrey Strahan.

Institution of Civil Engineers.—*January 11:* The Electric Locomotive, F. W. Carter.

Institution of Mechanical Engineers.—*December:* The Design of High-Pressure Electrical Distribution Systems, J. R. Beard.

Iron and Coal Trades Review.—*December 17:* Underground Haulage Gear with Speed of Electromotor reduced by Worm Gear. *December 24:* Hardy Patent Pick Co.'s 'Hardiax' Coal Cutter. *January 7:* Locomotive for Hauling Coal from Natal Coalfields to the Rand, the largest locomotive ever built in Great Britain.

Mining Institute of Scotland.—*December 11:* Method of Forming a Shaft Pillar for Thin Beds, J. Black.

Mining Journal.—*December 11:* Platinum Occurrences in Spain, T. C. Earl. *December 18:* Gold Deposits in Tierra del Fuego, T. C. Earl. *December 25:* New Peruvian Mineral Export Taxes. *January 1:* Gold in Cornwall, Brenton Symons and Henry Edwards.

Mineralogical Society.—*November 9:* Characteristics of Torbernite, A. F. Hallimond; Crystals of Iron Phosphide obtained from a Blast-furnace, L. J. Spencer.

National Association of Colliery Managers, Yorkshire Section.—*December 11:* Controlling the Weight of the Roof in Coal Mines, both for Safety and to assist the Mining Operations, W. Dakin.

South Staffordshire and Warwickshire Institute of Mining Engineers.—*December 7:* Geology of the Kent Coalfield, E. A. Newell Arber.

Colonial.

Australasian Institute of Mining Engineers.—No. 19, 1915. Pyrite Smelting Practice at Mount Lyell, R. E. Sticht; Mining Methods at Mount Lyell, R. M. Murray; Stope Survey Practice at Mount Lyell, G. F. Jakins and L. J. Coulter; Lake Margaret Hydro-electric Power Station, G. W. Wright.

Canadian Mining Institute Bulletin.—*December:* Notes on Mine Ventilation, John Shanks.

Canadian Mining Journal.—*November 15:* Treatment of Molybdenite Ores; Granby Consolidated M.S. & P. Co. Annual Report. *December 1:* Gold Discovery near Dryden; Gold Deposits of Dutch Guiana, J. B. Percival. *December 15:* Prospecting

Gold Gravels with Keystone Drills; Evolution of Ore Dressing Methods, R. H. Richards.

Chemical, Metallurgical, and Mining Society of South Africa.—*October:* Clean-up Room Practice at the Simmer Deep, W. H. Jane and E. Davey; Continued Discussion on J. Moir's paper on Dust in Mine Air; Discussion on H. R. Adam's paper on Antimonial Gold Ores of Murchison Range. *November:* Chief Sources of Accidents in the Witwatersrand Mines, C. E. Hutton, Inspector of Mines.

Mining and Engineering Review (Melbourne).—*November:* Considerations deciding between Flotation and Wet Concentration, particularly in connection with Complex Sulphides; the New Australian Metal Exchange.

Monthly Journal of Chamber of Mines of Western Australia.—*October:* Adverse Conditions with regard to Costs of Materials and Taxation, affecting Gold Mines in West Australia.

Queensland Government Mining Journal.—*November:* Boring for Oil in the Roma District, W. E. Cameron; Annan River Tinfield, final article of series, giving also information with regard to occurrence of wolfram, molybdenite, and other minerals.

South African Mining Journal.—*November 13:* The Dumb-bell Tube-Mill, G. A. Robertson. *November 20:* Mining Prospects in German East Africa; Valuation of Gold Mining Shares, a serial article. *November 27:* Mining Prospects in German East Africa, Oliver King; Transvaal Chamber of Mines' Regulations in connection with more liberal arrangements for Holiday Leave for Mine Employees other than Officials; Coal Prospects in the Karoo, Cape Province, A. L. Chambers, a report on coal occurrences in the Laingsburg district; Problems of the "New Rand," extracts from A. R Sawyer's report on borings conducted by him in Heilbron district, Orange Free State. *December 4:* The New Miners' Phthisis Inquiry ordered by the Union Assembly; the Position and Prospects of the Rooiberg Tin Mines; Suggestions for a New Gold Law in the Pilgrim's Rest District, C. Howard.

South African Institution of Engineers.—*November:* Testing a Large-Type Babcock & Wilcox Boiler.

Foreign.

American Institute of Mining Engineers Bulletin.—*December:* Protecting California Oilfields from Damages by Infiltrating Water, R. P. McLaughlin; Notes on Flotation, J. M. Callow; Effect of Carbon on the Physical Properties of Heat-Treatment Carbon Steel, J. H. Nead; Determination of Grain Size in Metals, Zay Jeffries, A. H. Kline, and E. B. Zimmer; Magnetic Studies of Mechanical Deformation in Certain Ferro-Magnetic Metals and Alloys, H. Hanemann and Paul D. Merica; Washed Metals, H. D. Hibbard and E. L. Ford; Manganese Steel Castings in the Mining Industry, W. S. McKee.

The Chemical Engineer (Chicago).—*November:* Electric Steel Costs, F. T. Snyder, from a paper presented to the San Francisco Meeting of the Electrochemical Society.

Colorado School of Mines Magazine.—*December:* Methods for the Determination of Tungsten in Ores.

Engineering Magazine.—*December:* Recording Power Plant Operations, J. C. Smallwood; Handling Material in Manufacturing Plants, Overhead Cranes, Wall Cranes, and Jib Cranes, R. L. Streeter.

Engineering and Mining Journal.—*December 4:* Magnetic Separation in Sardinia, Charles W. Wright; Building the Tough Oakes Mill—III., J. A. Baker; Oxyacetylene Welding at Braden, Alma Ek and J. R. Thill; Juneau Gold Lode. *December 11:* Flotation of Silver-Lead Minerals at a New South Wales Mine, H. H. Smith; the Silver Peak Mill at Yerranderie described; Natural Gas, its Occurrence and Properties, Dorsey Hager; Bardill Drossing Apparatus. *December 18:* Sluicing Methods at Fairbanks, H. J. Ellis; Ashio Copper-Smelting Works; Flotation at Miami, Globe, Arizona; Drill Steel and Its Treatment, E. M. Weston; Stone's Flotation Apparatus. *December 25:* Gas-Fired Reverberatory Furnace at Sulitjelma, Norway, C. Offerhaus: Mexican Mining Taxes, a petition to the Carranza government from the leading operators; Development of Dredging in Yukon Territory; Flotation at Gold Hunter Mine.

Franklin Institute Journal.—*December:* Possible Sources of Potash in America, F. K. Cameron; Cracking and Distillation of Petroleum under Pressure, B. T. Brooks.

Iron Age.—*December 9:* Coke Ovens Heated from Above, a translation of an article by Oskar Simmerbach in *Stahl und Eisen*. *December 16:* Symposium on Industrial Safety, reported from a meeting of the American Society of Mechanical Engineers.

Metallurgical and Chemical Engineering.—*December 7:* Alumina in Steel, G. F. Comstock; Solution Stratification as an Aid in the Purification of Electrolytes, F. R. Payne, read before the San Francisco Meeting of the American Electrochemical Society; Flotation at the Consolidated Arizona Smelting Co., Humboldt, Arizona, an exhaustive discussion with recoveries and costs; Thermal Principles of the Blast-furnace—II., J. E. Johnson, Jr.; Solution of Smoke, Fume, and Dust Problems by Electrical Precipitation, Linn Bradley.

Mining and Engineering World.—*November 27:* Nevada Packard Reduction Plant at Rochester, Nevada, K. Freitag; Purifying Water for Mine Power Plants, M. F. Newman. *December 4:* Burning Coal Dust in Reverberatory Furnaces, C. O. Bartlett. *December 11:* Calumet and Arizona Co., Warren Mining District, Arizona, C. A. Tupper; Treatment of Silver Furnace Fume by the Cottrell Process, C. H. Aldrich; Shaft Sinking in a Michigan Iron Mine; Potash in certain Copper Ores and Tailings. *December 18:* Granite Mountain Hoist of the North Butte M. Co., G. B. Rosenblatt.

Mining and Metallurgical Society of America.—*Bulletin, November 30:* Discussion of Standardization Report; Tests of the Lungwitz Zinc Smelting Process.

Mining and Scientific Press.—*November 27:* Technical Reminiscences, D. W. Brunton; Cyanidation in Western Australia, V. F. Stanley Low; Electrical Theory of Flotation [continued *December 11*], T. M. Bains, Jr.; Plain Writing, G. O. Smith; Precipitating Action of Carbon in Cyanide Solutions, W. B. Blyth. *December 4:* Diamond Drilling, P. B. McDonald; Grouting in a Shaft, J. R. Reigart. *December 11:* Fast Driving in a Michigan Iron Mine, J. E. Hayden; Plant Construction Costs in Korea, A. E. Drucker; Precipitation with Zinc Thread, J. A. Carpenter: Prospecting on the Chiksan Concession, C. W. de Witt; Flotation Plant of the Utah Leasing Company, H. Salinger, from *The Salt Lake Mining Review*. *December 18:* Extra-Lateral Right, L. F. S. Holland; Fluorspar Mine in Colorado, H. F. Lunt; Electrostatic Separation of Pyritic Zinc Ores, J. H. Lewis; Effects of Soluble Components of Ore on Flotation. *December 25:* Flotation—A Paradox, D. H. Norris; Hennen Jennings, and Mining on a Big Scale, an interview by T. A. Rickard; Heavy Timber Construction, P. B. McDonald.

NEW BOOKS AND OTHER PUBLICATIONS

Metals and Metal-Working in Old Japan. By Professor W. Gowland, F.R.S. Octavo, paper covers, 80 pages, with many illustrations. London: The Japan Society.

There are many among our readers who do not fully recognize the many talents of our doyen of metallurgists, Professor Gowland. Like the junior boys at the colleges, we are apt to neglect our opportunities for instruction and enlightenment. It is well to say, therefore, that he is not only a sound scientist in the domain of metallurgy, but an acknowledged antiquary and archeologist. As an indication of the confidence in which he is held among antiquaries, it may be mentioned that to him was deputed the researches connected with Stonehenge a dozen or more years ago. His knowledge of things Japanese was gained during his long tenure of office at the Japanese Mint. He was one of the first foreigners admitted to a confidential position in the councils of the secret monarchy. While in that country, distant in those days, he had exceptional opportunities for gratifying his natural instinct for archeological study. Since his return to this country, over twenty years ago, he has enriched the literature of many learned societies by his records of things Japanese, such as the Institution of Mining and Metallurgy, the Institute of Metals, the Anthropological Society, and the Japan Society. The publication now under notice was presented to the Japan Society, and it deals with the earlier history of Japanese metallurgy. Professor Gowland was really one of the founders of archeological research with regard to Japanese metallurgy, for, before his activities, the local records were incomplete, if not non-existent. Under his direction, a great number of ancient mounds and tumuli were opened, and an enormous collection of old metal instruments and implements of all kinds were collected. Descriptions of these are given, classified according to the metal, with historical accounts of the earlier Japanese methods of smelting and working metals. The publication will be treasured by all who appreciate the conscientious perfection of the metallurgical operations in Old Japan.

Text-Book of Geology. By Louis V. Pirsson and Charles Schuchert. Cloth, octavo, 1050 pages, with many illustrations. New York: John Wiley & Sons. London: Chapman & Hall. Price 17s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This book has been prepared by the professors in Yale University. Mr. Pirsson is responsible for the section on Physical Geology, and Mr. Schuchert for that on Historical Geology. It is an excellent handbook of physical and stratigraphical geology, well illustrated and printed, and will prove useful to American students.

Sampling and Chemical Analysis of Iron and Steel. By O. Bauer and E. Deiss, translated by W. T. Hall and R. S. Williams. New York: McGraw-Hill Book Co. Price 12s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

In arriving at a correct analysis of metals the necessity for obtaining of a truly representative average sample is often overlooked, and the technical service is devoted chiefly to the accurate analysis of the sample. This is the experience of the mining engineer, as we have continually urged. Refinements of analytical methods are of no value if the sample does not accurately represent the bulk. The present book enlarges on the necessity for exact sampling of iron and steel, and for watching for the segregation of the component metals, which is likely to introduce errors in the analysis of samples. The authors are on the staff of the German Testing Bureau, under Martens and Heyn. The translators are with the Massachusetts Institute of Technology, and they have added a number of other methods developed in America.

South-West Africa during the German Occupation, 1884 to 1894. By Albert F. Calvert. Cloth, octavo, 136 pages, with 230 plate illustrations. London: T. Werner Laurie. Price 5s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Several times recently we have referred to the literary activity of Mr. Calvert, and his ability for making readable compilations of information on a great variety of subjects. In this book he discusses the history of the German ownership of South-West Africa, and the nature and resources of the country. The general geology, the copper deposits, and the diamond-mining iudustry are outlined. The best part of the book is probably that devoted to photographs of the country and its people, though these can only be called a miscellaneous collection. We do not understand Mr. Calvert's dedication: "To General Louis Botha, Prime Minister of Cape Colony and Commander of the Cape Union Forces." This confusion of ideas as regards history and geography makes us rub our eyes.

Determinative Mineralogy. Second Edition. By J. Volney Lewis. Cloth, octavo, 160 pages. New York: John Wiley & Sons; London: Chapman & Hall. Price 6s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Two and a half years ago we noted the publication of this book on determinative mineralogy. The new edition contains many rearrangements and additions that will greatly increase its practical value to those who require the standard tables usually found elsewhere, and who do not care to turn backward and forward in the same book for references. The author also introduces a large number of the more delicate laboratory tests. The book is intended solely for the class-room and not for the field.

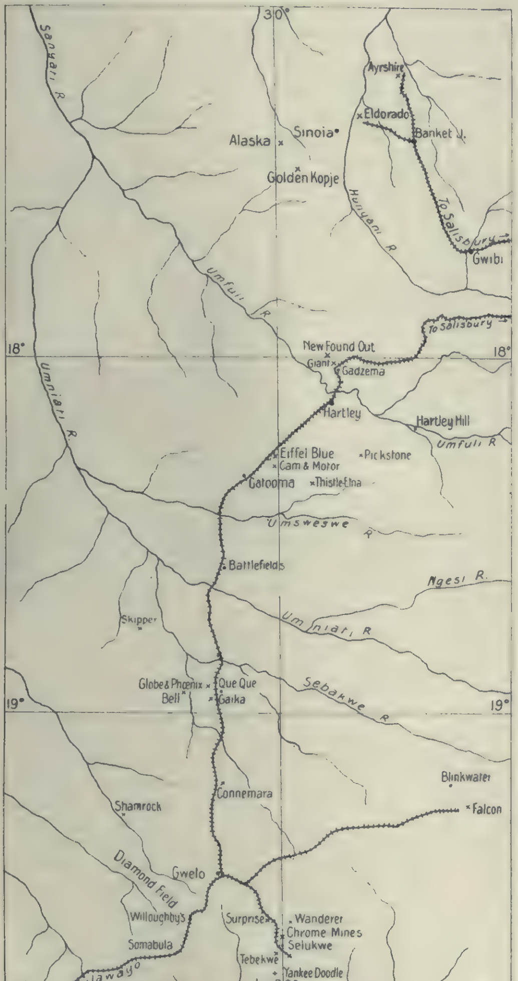
Principles of Physical Chemistry. By Edward W. Washburn. Cloth, octavo, 450 pages, illustrated. New York: McGraw-Hill Book Co. Price 15s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is a text-book prepared by the professor of physical chemistry in the University of Illinois. It discusses the properties of gases, liquids, solids, and solutions, the principles of electricity and ionization, chemical equilibrium and the phase rule, radio-activity, thermodynamics, atomic structure, thermo-chemistry, etc. The matter is well presented, and the author is always easy to follow, so that the book should prove highly acceptable.

Geological Society of South Africa.—The Transactions of this Society contain many important geological papers. A comprehensive index to the first thirteen volumes, 1897 to 1910, has been prepared by A. Reynell. The references are remarkably full and complete.

YEARLY REPORTS OF MINING COMPANIES

Cam & Motor Gold Mining.—This company belongs to the London & Rhodesian Mining & Land group, which is controlled by J. & S. Weil. It was formed in 1910 to acquire gold mines at Gatooma in the Hartley district of Rhodesia. Development has been chiefly confined to the Motor section, and the Cam and Good Shepherd claims have been sold to the



Central Part of
SOUTHERN RHODESIA

Giant company belonging to the same group. The ore contains antimony and arsenic. The metallurgical plant, which was described in our issue of August 1913, was started in February 1914. The report for the year ended June 30 shows that 142,702 tons of ore was treated for a yield of gold worth £216,787. This is an extraction of 30s. 4d. per ton, and judging by the figures given in connection with the ore reserves, the percentage of recovery is approximately 75%. The working cost in Rhodesia was £176,980 or 24s. 9d. per ton, leaving a working profit of £45,086, out of which £2203 was paid as London expenses and £5848 as debenture interest, and £21,006 was written off for depreciation. Capital expenditure of £53,739 was incurred, chiefly on new plant. The amount of development done during the year was restricted owing to the necessity of completing the mill, and the reserve stands at 739,844 tons averaging 41s. 4d. per ton, as compared with 867,032 tons a year ago. A winze is being sunk below the 6th or bottom level, and for the 94 ft. so far sunk the average assay-value of the ore is 60s. 3d. per ton.

Wankie Colliery. — This company was formed in 1899 to develop coal deposits in Southern Rhodesia, between Bulawayo and the Victoria Falls, and is controlled by the British South Africa Co. We gave details of the deposits in our issue of May 1914. At first the venture was a comparative failure, and in 1909 the shares were written down from £1 to 10s. Subsequently the market for the coal expanded, and handsome profits were made; so a year ago the nominal capital was restored to its former level. Increased contracts for the supply of coke were at the same time made with the Union Minière du Haut Katanga. The report for the year ended August 31 last shows that 267,205 tons of coal was sold, and 31,591 tons of coke, as compared with 239,969 tons and 17,272 tons respectively the year before. The accounts for the year are complicated by the reconstruction in December 1914, and the report now published sets forth only the results for the eight months from December to August. The profits were sufficient to pay 7½% dividend on the £410,000 capital, and another 5% was paid out of the accumulated profits from August to December 1914. The developed reserves are estimated at 3,000,000 tons.

Witbank Colliery.—This company was formed in 1896 to acquire coal deposits in the Middelburg district of the Transvaal, about 90 miles east of Johannesburg. The sale of coal commenced in 1898, and increased gradually until 1909, since which date the yearly output has been fairly regular. David Wilkinson, of Neumann's, is consulting engineer, and J. K. Addie is manager. The report for the year ended August 31 shows that the rebellion hindered operations, and the output was 10% lower than during the previous year. The production at the Witbank mine was 429,170 tons, and from the Uitspan mine 262,007 tons, making a total of 691,177 tons. The gross profit for the year was £67,396, and £42,000 was distributed as dividend, being at the rate of 20% as compared with 25% the year before.

Cape Copper.—This company was formed in 1863 to work the Ookiep copper mine in Namaqualand, on the west side of the Cape province, South Africa, not far from the boundary of 'German' South-West Africa. For many years high-grade ore was shipped to the company's smelter at Britonferry, South Wales. The supplies of rich ore are nowadays small, and not much is sent to Wales, most of the output being smelted locally and the resulting matte shipped. The report for the year ended April 30 shows that 13,345 tons, averaging 10·88% copper, was raised at the Ookiep mine. Of this, 1025 tons averaging 23·7%

was shipped, and 12,320 tons was delivered to the smelter. At the Nababeep mines 69,798 tons averaging 4·4% copper was raised and sent to the smelter. At both properties the reserves have been fully maintained, being 6000 tons averaging 20% at Ookiep and 160,000 tons averaging 5% at Nababeep. Two years ago the company purchased the Rakha Hills copper property in Chota Nagpur, India. The mine equipment and the concentration plant have been completed, and a commencement of operations may be expected at any time. The plant has a capacity of 300 tons per day. It was intended originally to ship the concentrate to Britonferry, but owing to the great rise in ocean freight it was decided to erect a smelting plant. This should be in operation in six months time. The ore reserve is estimated at 344,991 tons averaging 4% copper. The accounts show a profit of £33,212, out of which £10,841 has been paid as British and Cape income taxes, £5400 has been distributed as dividend on the preference shares, at the rate of 6%, and £18,000 on the ordinary shares, at the rate of 2½%.

Sheba Gold.—This company was formed in 1884 to acquire a group of gold-mining properties at Barberton in the eastern Transvaal. Dividends were paid from 1891 to 1898, and subsequently there came a series of disappointing years. In 1904 the company was reconstructed, and again in 1911, when the par value of the shares was reduced from £1 to 5s. Of recent years, attention has been centred on one property, the Zwartzkopje, instead of spreading the operations over a great number of workings, a policy that has been successful, dividends having been paid regularly since. The present outlook is, however, gloomy again. The report for the year ended June 30 last shows that 84,910 tons of ore averaging 10½ dwt. gold per ton was mined, of which 55,411 tons averaging 11¼ dwt. came from the Zwartzkopje, and 24,738 tons averaging 9¼ dwt. from the Intombi. The yield of gold was worth £143,564. During the previous year, 74,965 tons of ore was treated for a yield of £164,713. The yield per ton thus fell from 55s. 9d. to 44s. The working cost during the past year was £104,667, leaving a working profit of £38,160, out of which £5374 was paid as taxes, £5148 was written-off for depreciation, and £26,973 was distributed as dividend, being at the rate of 10%. Development during the year has maintained the total ore reserve throughout the various properties, but the average content shows a marked fall. The reserve at Zwartzkopje is only 10,700 tons, and the assay-value only 8 dwt. Additions to the reserve have been made at Intombi, Southern Cross, and Insimbi, and the average assay on these properties is much the same as at Zwartzkopje. J. T. Milligan, the manager, states that a vigorous policy of development is necessary.

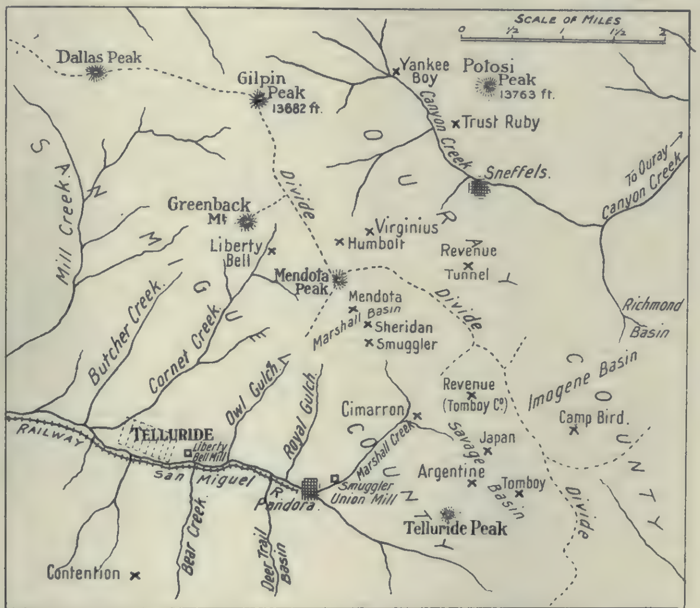
Knights Deep.—This company belongs to the Consolidated Gold Fields group, and was formed in 1895 to acquire property in the dip of the Glencairn and Knights in the eastern part of the Rand. In 1913 an amalgamation was effected with the Simmer East, the two companies having previously been worked conjointly as to both management and milling accommodation. The ore is of low grade, but as the stopes are wide the mining cost is also low. No sorting is done. The report for the year ended July 31 last shows that the mill containing 400 stamps and 11 tubes was fully occupied, 1,172,920 tons of ore being treated for a yield of 209,682 oz. gold, worth £878,749, or 14s. 11d. per ton. The working cost was £713,638 or 12s. 2d. per ton, leaving a working profit of £165,111, or 2s. 9d. per ton. Out of the profit, £4880 was paid as profits tax, £2912 as debenture interest, £22,700 devoted to redemption of debentures, £4978 paid to the Miners' Phthisis fund, and £92,940 was distributed as dividend, being at the rate of 12½%. The debentures are now practically extinguished. The ore reserve is estimated at 2,627,000 tons averaging 4¼ dwt. per ton. These figures do not include the ore obtainable by reclamation of pillars. During the past year, 57% of the ore mined was drawn from this source.

Van Ryn Gold Mines Estate.—This company was formed in 1892 to acquire property on the outcrop in the Far East Rand, and it was in fact the pioneer of mining in that part of the Witwatersrand. The assay-value of the ore has throughout been lower than that of the outcrop mines in the central part of the Rand, and is also lower than that of some of the ore found in adjoining deeper-level mines to the south and east. It was not until 1904 that dividends were paid. The technical management is in the hands of the Albu group. The report for the year ended June 30 shows that the yield per ton milled fell to 25s., as compared with 26s. 10d.; and that at the same time the working cost fell from 16s. to 14s. 10d. per ton. The amount of ore raised was 502,148 tons, and after the rejection of 8% waste, 462,850 tons was sent to the mill. The yield of gold by amalgamation was 96,568 oz., and by cyaniding 41,247 oz., a total of 137,815 oz., worth £579,996. The working cost was £344,298, leaving a working profit of £235,697, or 10s. 2d. per ton milled. The dividend absorbed £225,000, being at the rate of 45%, the same as last year. The ore reserve is calculated at 1,973,000 tons averaging 26s. 4d. per ton, showing practically identical tonnage as compared with the year before, but a fall of 1s. 4d. in average content.

Tanalyk Corporation.—This company was formed in 1912 for the purpose of purchasing the whole of the shares of the South Urals Mining & Smelting Co., a Russian organization owning copper and gold deposits near those of the Kyshtim Corporation under the auspices of which the company was floated. The chief copper mines are Tanalyk, Mambet, Graffsky, and Ulali, and the gold mines are the Semeonovsky and Tuba. Smelting in reverberatories commenced in April 1914. The report of the directors now published covers the Russian year 1914, and it is accompanied by a report by R. Gilman Brown, the consulting engineer, bringing the information up to October last. During twelve months, 32,000 tons of ore was smelted, yielding 573 tons of blister copper, which contained 12,033 oz. gold, and 106,578 oz. silver. Two small blast-furnaces have been erected to treat the harder ore from Ulali. The cyanide plant at Semeonovsky was started in August. Operations at the blast-furnaces are hindered by the shortage of coke, and at the cyanide plant by the scarcity of zinc. Development at the mines has been restricted owing to lack of available men. The most noteable feature has been the work at Ulali, where a large body of ore has been proved averaging 7½% copper and 3½ dwt. gold. Below the 210-ft. level bore-holes fail to indicate a continuance of high-grade ore, so the eventual value of the mine is by no means certain. At the Tuba a big outcrop of oxidized ore high in gold and silver is being developed, which is considered to be the gossan capping of a sulphide vein. The ore reserves were calculated on April 1 as follows: Mambet, 65,800 tons averaging 2·3% copper, 7·1 dwt. gold, and 7·4 oz. silver; Tanalyk, 10,000 tons averaging 3·5% copper, 3·4 oz. gold, and 2 oz. silver; Graffsky, 5500 tons averaging 2·1% copper, 6·6 dwt. gold, and 3·9 oz. silver; Ulali, 10,000 tons averaging 7·9% copper, 3·4 dwt. gold, and 1·2 oz. silver; Semeonovsky, 140,000 tons averaging 12 dwt. gold, and 0·7 oz. silver.

Camp Bird.—This company was formed in 1900 by F. W. Baker and John Hays Hammond to acquire from Thomas F. Walsh the Camp Bird gold mine in Ouray county, Colorado. After yielding handsome profits for ten years, the lower levels showed signs of impoverishment, and on the initiative of A. M. Grenfell, then chairman of the board, other properties were sought, with the eventual object of making the company a mines-investment organization. The Santa Gertrudis silver mine was floated in this way, and financial obligations were undertaken in connection with the Messina company. On Mr. Grenfell's failure eighteen months ago, H. C. Hoover was elected chairman. The report now issued covers the year ended June 30 last. From this it is seen that 32,313 tons of ore was treated for a yield worth £196,149, being £6. 1s. 4d. per ton. These figures compare with 30,595 tons, £164,669, and £5. 7s. 7d. the year before. Gold, silver, copper, and lead appear in the receipts. About 58% of the value is obtained by amalgamation, 37% in the auriferous and argentiferous lead and copper concentrates, and 5% by cyaniding the tailing. The yield per ton was considerably higher than expected. The working cost was £112,548, or £3. 9s. 7d. per ton. The ore reserve is estimated at 15,900 tons calculated to yield a profit of £56,000. An income of £50,710 arose from the holding in Santa Gertrudis shares, and the available profit for the year was £117,899. Out of the profit, £45,473 has been paid as preference dividend, being at the rate of 7%, and £55,002 as dividend on the ordinary shares, being at the rate of 5%. In addition £8141 has been written off the loss due to the company's funds being lodged with Chaplin, Milne, Grenfell & Co. at the time of their failure, and £30,000 has been written off the holding in the Central American Goldfields Syndicate, an investment that has been dropped.

Santa Gertrudis.—This company is a subsidiary of the Camp Bird, particulars of which are given in the preceding paragraph, and it owns a silver mine at Pachuca, Mexico. It was floated at the end of 1909, with a capital of £1,500,000, of which £1,113,096 is held by the Camp Bird. During the last two years there have been three causes of anxiety, the Grenfell failure, the Mexican revolutions, and the poor results of development on the 18th level and below. The report for the year ended June 30 last shows that milling was resumed on July 6, 1914, and that the amount treated gradually increased for a few months, but in December it fell to 40% capacity. The output over the whole year averaged about 50% of the capacity. The scarcity of cyanide, zinc dust, and lime greatly interfered with operations. The amount of ore treated was 211,669 tons averaging 26s. 2d. per ton. The yield was 10,727 oz. gold and 2,000,856 oz. silver, worth £249,727, being a yield of 23s. 7d. per ton. The net profit was £44,741, out of which £5582 was written off the loss due to funds being in the hands of Chaplin, Milne, Grenfell & Co. at the time of their failure, and £10,000 placed to reserve. The balance of profit was £29,159, to which was added the balance £101,526 brought forward from the previous year. The shareholders received £75,000, being at the rate of 5%. Development at depth has been suspended until conditions become normal. Lateral exploration has proved the existence of a smaller parallel lode, as recorded already in our columns. The ore reserve is estimated at 1,287,000 tons, averaging 1·2 dwt. gold and 12·6 oz. silver per ton, 90% of the metals being extractable.



PART OF COLORADO, SHOWING POSITION OF CAMP BIRD MINE.

Central Chili Copper.—This company was formed in 1894 to work the Panulcillo copper mine, near Coquimbo, Chile, that had previously been operated for many years by the Panulcillo company. Neither the present nor the old company has given much return on capital invested. A majority of shareholders are resident in France. The report for the year 1914 just published shows that 28,602 tons of ore was raised averaging 2·8% copper, and that 27,160 tons was smelted together with 23,756 tons averaging 8·4% of purchased ores. The resulting matte contained 2491 tons of copper, 1220 oz. gold, and 44,090 oz. silver. This matte was shipped to New York. The accounts show a loss of £32,612.

Sulphide Corporation.—We have on several occasions recorded the history of this company, which operates the Central mine at Broken Hill, New South Wales, and which is noted as the locus of the original development of the Minerals Separation flotation process. The report covering the year ended June 30 last records that for some time after the outbreak of war the mine and mill were operated on alternate weeks, and were working altogether 9½ months out of the twelve. The amount of ore raised was 200,079 tons, and 197,180 tons was sent to the mill, averaging 15·5% lead, 17% zinc, and 12·6 oz. silver per ton. The lead concentrate recovered was 34,306 tons averaging 64·9% lead, 7·6% zinc, and 33·7 oz. silver. At the flotation plant the yield was 65,513 tons of zinc concentrate, which was afterward treated on tables, where the ultimate products were 61,247 tons of zinc concentrate averaging 46% zinc, 7·9% lead, and 16·1 oz. silver, and 2543 tons of lead concentrate averaging 57·9% lead, 15·2% zinc, and 42·8 oz. silver. The plant for treating accumulated slime was closed on the outbreak of the war, and has been idle since. During the few weeks of work, 7266 tons averaging 17% lead, 19·1% zinc, and 15·6 oz. silver, was treated by selective flotation, producing 1055 tons of lead concentrate averaging 53% lead, 19·4% zinc, and 48·4 oz. silver, and 2193 tons of zinc concentrate averaging 41·7% zinc, 15·2% lead, and 17·5 oz. silver. The various lead concentrates were smelted at Cockle Creek, together with purchased ores. The despatch of zinc concentrate to Germany ceased in August 1914, but the usual small deliveries to the Central Zinc Co. in the north of England continued. Recently, contracts have been made with American zinc firms for the sale of concentrate in the United States. At the mine the amount of development done was limited, but nevertheless the reserve was increased by 27,679 tons, and now stands at 2,039,000 tons. Of the ore mined during the year a larger proportion than usual came from the upper levels, and the average metal content was therefore higher.

Ida H. Gold Mining.—This company was formed by the North-Waddington group in 1900 to acquire a gold mine in the Mount Margaret district of West Australia. From 1902 to 1906 dividends aggregating 142½% were distributed on a capital of £54,000. In 1911 the management was changed and Hooper, Speak & Co. were appointed consulting engineers and general managers. The payment of dividends, though on a greatly reduced scale, was resumed a year ago. The issued capital is now £70,581. The report for the year ended June 30 shows that 16,727 tons of ore was raised and sent to the mill, where 11,563 oz. was extracted by amalgamation, and 2293 oz. by the treatment of 659 tons of concentrate, making a total yield of 13,856 oz. worth £58,848, or 70s. 4d. per ton. The working cost was £37,817, or 45s. 2d. per ton, and £14,364 was written off for shaft-sinking and mine development. The accounts show a profit of £4701, out of which £3529 has been paid as dividend, being at the rate of 5%. The ore reserve is estimated at 8088 tons, together with 4872 tons of probable ore. In order to decrease the cost of handling, the inclined part of the shaft has been continued upward to the surface, and the metallurgical plant removed to the new shaft-mouth. At the meeting of shareholders, the chairman spoke gloomily of future prospects, but this view is apparently not shared by the consulting engineers.

Chendai Consolidated.—This company was formed in March 1914 as a consolidation of the Redhills, Sungei Chendai, and Chendai Lodes companies, and owns lode-tin properties in the Kinta district of Perak, Federated Malay States. The report for the year ended April 30 shows that part of the property has been worked by tributers, who won 123½ tons of tin concentrate. The proportion of the income accruing to the company was £1095. A new stamp-mill and concentration plant has been erected at the Chendai mine, and its start is expected at any time now. The issued capital of the company is £45,950, and £8408 had been spent on the new plant up to April 30 last.

Rambutan.—This company was formed in 1905 to acquire an alluvial tin property in the northern part of the Kinta district of Perak, Federated Malay States. It was promoted by James Wickett of Redruth, and Osborne & Chappel are the managers. A suction dredge was used at first, but proved unsuitable for the ground, so hydraulicking has been substituted. The report for the year ended June 30 last shows that the new installation has given satisfaction, 566,000 cubic yards having been treated for a yield of 236 tons of tin concentrate. The yield per yard was 15 oz., worth 8·8d., and the working cost was 3·4d. The accounts show an income of £20,878 from the sale of concentrate, and a net profit of £11,876, out of which £5000 was distributed as dividend, being at the rate of 5%.

Deebook Dredging.—This company was formed in May 1913, with offices at Ringwood, near Melbourne, to acquire alluvial tin property at Renong, Siam. An interest is held by Lionel Robinson, Clark & Co. Arthur H. Miles is general manager. The report now issued covers the year ended May 31, 1915. No. 1 dredge was started on August 10, 1914, and from that date to May 31, treated 441,565 cubic yards, for a return of 209 tons of tin concentrate. This corresponds to a yield of 1·06 lb. per cu. yd. The accounts show an income of £17,116 from the sale of concentrate, a working cost of £12,981, and a working profit £4184. A dividend of £4500 has been paid, being at the rate of 5%. After paying royalty and smelting charges, the average value of the yield per yard was 9·3d., and the cost 7·05d., leaving a profit of 2·3d. per yard. The cost was higher than anticipated, owing largely to an unusually dry season. Since the close of the year under review, the cost has been substantially reduced, being only 5·13d. per yard. A second dredge started on August 9, 1915, and from then to the date of the directors' report, October 11, treated 69,549 cu. yd. for a yield of 40·7 tons of tin concentrate, being an average extraction of 1·31 lb. per yard.

Naraguta (Nigeria) Tin Mines.—This company was formed at the beginning of 1910 to acquire alluvial tin ground at Naraguta, Northern Nigeria. Other properties have since been acquired at Karama in the Ninkada district, and at Sho, near Zungeru. F. N. Best is chairman, C. G. Lush is consulting engineer, and F. O'D. Bourke is manager. The report now issued covers the year ended March 31 last. During this period 654 tons of tin concentrate was won, as compared with 887 tons the previous year. The reduction in the output was due chiefly to the short supply of labour, owing to Government requirements in connection with the Cameroons expedition. The average price realized per ton was £103. 17s. 6d., being £12. 2s. 6d. below the previous year, and £43. 17s. 6d. below that of 1913. The accounts show an income of £56,374, and a net profit of £2029. The new pipe line has given satisfactory results, and a substantial reduction of operating expenses is expected.

61

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

EDGAR RICKARD, *Managing Director.* H. FOSTER BAIN, *Editor.* EDWARD WALKER, *Assistant Editor*

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CONTENTS.

REVIEW OF MINING

Introduction.—Cornwall operators have been greatly interested and pleased at the development of a new orebody in the East Pool & Agar, of which our correspondent writes elsewhere. The event is important in that it shows that not everything good has already been found, despite the years the mines have been worked. It confirms also the opinion of Mr. J. H. Collins which we quoted in our issue of October last, that developing the less known veins of the region was more likely to be profitable than too much pumping of water from old stopes. In this case we believe it was Dr. Malcolm Maclaren who pointed out the probable value of the vein on which the ore was found, while Mr. M. T. Taylor and the other engineers of the Bewick Moreing staff deserve the credit of actually finding the ore. The Government grant for the study of ore dressing methods in Cornwall is now available whenever the Royal Cornwall Polytechnic completes its task of arranging for local co-operation. In the meanwhile we seem to have opened a mine of information by our notes on the use of glass-top tables. We present this month additional material and still must leave important phases of the matter for discussion later.

Farther afield we note renewed activity in the diamond market, with especial call for industrial sizes. Washing has already been resumed at De Beers and we anticipate that mining will follow before many months, which will promptly affect matters on the Rand by creating a labour shortage. For the present the situation there is fairly easy, and development of the Far East Rand is gathering headway. We give elsewhere details of the plan finally adopted for financing the Daggafontein. Springs, Brakpan, Geduld, Modder Deep all present such satisfactory ore reserve statements that it is not surprising that plans are being made for opening the Cloverfield and Welgedacht properties. In Australia the strike at Broken Hill is over. Metal production was not affected, the smelters having good stocks of ore on hand. The Arizona copper miners' strike is settled, as we note elsewhere. Production of all the metals is at full capacity in the United States, but wages are high, and a labour shortage will prevent any rapid further expansion. The floating labour that in other years flocked from Europe to America in times of industrial activity is otherwise engaged this year.

In Europe mining is active, especially along the front through France, Belgium, and Italy. We understand that the prospects indicate developments commensurate to the risk and expenditure. Winter mining, as every Alaskan, Klondiker, or Siberian knows, involves much hard and disagreeable labour, with hopes centred upon the result "when the season opens." In this instance the miners and their friends are alike awaiting results with the same confidence with which a good miner is wont to light his pipe in the drift while waiting "to count the shots."

Transvaal.—The output of gold on the Rand during January was 759,852 oz., and in outside districts 27,615 oz., making a total of 787,467 oz., worth £3,344,948. The figures for December were 755,101 oz., 26,010 oz., 781,111 oz. and £3,317,949. The number of natives employed on the gold mines at the end of January was 209,835, as compared with 209,438 at the end of December, and 172,331 a year ago. The number employed at the diamond mines was 802, as compared with 132 reported at the end of December, the latter being the first return since the commencement of the war.

Terms of agreement between the Daggafontein and Consolidated Mines Selection, whereby the latter undertakes to subscribe working capital for the development of the Daggafontein mine have been finally settled. A new company is to be formed with a capital, at first, of £540,000 in £1 shares. Of these shares, 268,253 will be allotted fully paid to the Daggafontein, and 129,780 shares will be allotted to Henderson's Transvaal Estates in settlement of debt owing by Daggafontein. Consolidated Mines Selection agrees to find subscribers for 100,000 shares at par at once, and for a further 200,000 shares at par within two years as required. The latter company has options to purchase 115,874 shares at par, 125,000 shares at 22s. 6d., and 125,000 shares at 25s. during the next few years, and Daggafontein has the option to purchase 134,126 shares at par. The nominal capital of the company will have to be increased to meet the requirements connected with the issue of shares from time to time. It will be seen that Consolidated Mines Selection sees its way clear to provide over £700,000 for this enterprise.

Negotiations relating to developments of property in the Far East Rand have received a tonic owing to the success of the Daggafontein deal. There appears to be some prospect of the Cloverfield and the Welgedacht renewing operations, and possibly amalgamating interests. Both companies sunk shafts to the banket a few years ago and profitable deposits were proved, but funds were not available at the time for a continuance of development. The properties are both farther east than the Modderfonteins and Geduld, and their relative situation suggests joint working.

A calculation of reserves at Brakpan indicates a substantial increase during 1915. The figures at the end of December were 3,017,000 tons averaging 7·86 dwt. over 62 in., as compared 2,490,000 tons averaging 6·73 dwt. over the same width a year ago. Springs also shows a big advance from 553,000 tons averaging 10·3 dwt. over 52 in., to 1,125,000 tons averaging 10·4 dwt. over 57 in. At the Modder Deep the reserve has increased during 1915 from 2,450,000 tons, averaging 8 dwt. over 69 in. to 2,670,000 tons averaging 8·3 dwt. over 73 in. At the Geduld the increase is from 1,900,000 tons averaging 7·1 dwt. to 2,100,000 tons averaging 7·7 dwt.

A few months ago the directors of the New Modderfontein recommended the splitting of the £4 share into four shares of £1 each in order that transactions should be facilitated on the Stock Exchange. The Treasury has indicated its disapproval of the proposal, on the ground that money to be put into the expected speculative operations is better employed in other ways.

As foreshadowed last month, operations at the Randfontein Central are to be contracted, and only 600 stamps are to be employed this year. The total number of stamps is 1000, but the mills have never worked at full capacity. Whether better profits can be made by selective mining and by the crushing of less tonnage and of higher grade ore remains to be seen. At the present time the Randfontein Central stands as the biggest unprofitable mining enterprise in the world.

During the last three months there have been rumours of the discovery of high-grade ore below the dike at Knight Central, and the shares of the company have been active on the Stock Exchange. The cable published a few days ago confirms the rumours as far as assays go, but the distances sampled are so small that the importance of the discovery cannot be gauged. The following are the figures: 85 ft., assay 8·5 dwt. over 66 in.; 65 ft., assay 7·6 dwt. over 72 in.; 20 ft., assay 12·3 dwt. over 66 in.; this is not much on which to found a boom.

Recent developments at Bantjes have been disappointing, as has already been recorded in our columns. But a ray of hope came early in February in the form of a cable announcing that the drift started from the workings of the adjoining Main Reef West mine has disclosed 75 ft. of reef averaging 9·6 dwt. over 40 in. in the Leader, or 9·6 dwt. over 60 in. in the Leader and Main Reef combined.

The West Rand Central is a small mine between the Randfontein Central and West Rand Consolidated, and it has never made much return in the way of dividends. Owing to the uncertainty as regards the value of the ore reserve, J. W. H. Stubbs was asked to examine and report. He found not more than 1000 tons with an assay-value above the working cost, though about 20,000 tons was sufficiently close to this limit to warrant further examination. But expenditure in this direction is not recommended considering the general circumstances. There are no ore-shoots likely to continue downward, so that the development at depth is not advised, and in any case shaft-sinking could not be continued without first repairing some of the upper parts of the shaft. There is therefore no alternative but to suspend operations.

Rhodesia. — The output of gold during December was worth £331,376 as compared with £313,160 during November and £309,669 in December a year ago. The output for the year 1915 was £3,823,166, as compared with £3,580,207 in 1914, and £2,903,267 in 1913. The production at Shamva continues to increase, being £39,091 from 51,996 tons in December, as compared with £34,901 from 46,567 tons in November.

We give elsewhere the results of the first year's smelting operations at the Falcon gold-copper mine and an outline of the concentration and smelting methods. More recent information is to the effect that, during the six months ended December 31, 104,059 tons of ore was treated for a yield of blister copper containing 1795 tons of fine copper, 19,217 oz. gold, and 35,844 oz. silver. The blister copper is being shipped to America for refining, as no firm in this country can undertake the work. In sinking the shaft below the 7th level, a low-grade orebody has been unexpectedly found. Whether it is the main orebody raised by an upthrow fault, a branch of the main orebody, or an entirely new lode is not yet ascertained.

Rhodesia Limited announces that arrangements have been made to provide working capital for the Sabiwa mine. A subsidiary company is to be formed, and £75,000 is being raised on debentures. These funds should suffice to provide equipment and bring the mine to the producing stage. The company also announces the purchase of the Annasona, in the Bulawayo district, which is likely to become a producer almost immediately.

The lawsuit between the Amalgamated Properties of Rhodesia and the Globe & Phœnix, with regard to the ownership of certain veins worked by the latter, drags interminably. Each expert witness is exposed to a week or more of cross-examination. We are reminded of the case of Jarndyce *v.* Jarndyce, and wonder whether anything will be left for the companies after the lawyers' fees have been paid.

West Africa.—The output of gold in West Africa during December was worth £158,323, one of the highest returns yet made, and compares with £122,138 for November. The large margin between the figures for November and December is due partly to gold worth £8945 produced at Abbontiakoon having been accidentally omitted from the returns for the former month; and partly also owing to an increase of £4615 at Prestea Block A. The output for the year 1915 was worth £1,706,473, as compared with £1,727,044 in 1914, and £1,634,700 in 1913.

Nigeria.—With a yield for December of 533 tons, the highest monthly figure on record, the Nigerian output of tin concentrate for the year 1915 was brought to 5213 tons, as compared with 4708 tons during 1914, 5103 tons during 1913, and 2540 tons during 1912. At the present time Rayfield heads the list of producing companies with 60 tons per month, and is followed by Ex-Lands, Bauchi, and Naraguta with 50 tons each. Other companies producing over 30 tons per month are the Mongu, Forum, Bisichi, and Ropp.

Australasia.—The strike at Broken Hill is over and the mines are again working. The smelters at Port Pirie were not affected as the accumulated stocks of ore and concentrate were large. The labour trouble at Kalgoorlie, due to the strike of wood-cutters, did not last long, and the mine chiefly affected, the Golden Horse-Shoe, resumed operations after only a short period of idleness.

The Broken Hill Proprietary has received orders for steel for shell construction from the Munitions Department in London, the requisite tests having given satisfaction. The first consignment of 500 tons is to be shipped this month. The company is already supplying steel to twenty Australian manufacturers of munitions.

The Hampden Cloncurry at first delivered its matte to the Mount Elliott smelter nearby, but for the last three years has produced its own blister copper. The contract for sale was with Brandeis Goldschmidt until the outbreak of war. For a few months afterward the marketing of the output was difficult and operations were partly suspended. The Commonwealth Bank came to the rescue by lend-ing on the copper produced. The blister copper now goes to the Port Kembla works. The last half-yearly statement just issued shows that the company is again prosperous. The yield was 4366 tons of copper, 1191 oz. gold, and 35,802 oz. silver, obtained from 45,483 tons of ore, and the net profit was £112,195. Developments in the Hampden mine have not revealed any more high-grade ore, but bodies of pyritic ore averaging 4% copper, and of concentrating ore, have been discovered. At the Duchess mine the reserve of high-grade ore averaging 11% had been increased. The prospects at Trekelano and Pindora are promising and development by mining and diamond-drilling are in hand.

Since our paragraph relating to the Mouramba copper mine appeared in our last issue, news is to hand that two of the directors provided funds for re-starting the smelter, and that 120 tons of copper is now being produced per month. The company is reaping the benefit of the present high price of copper, and its success in getting going again should have a tonic influence on the copper mining industry of New South Wales. The Lloyd copper mine in the same district and belonging to the same group is in financial difficulties, for the bankers are pressing for the liquidation of a loan.

India.—At the Mysore mine the developments in the southernmost section, known as McTaggart's, are attracting attention. The east lode on the 3117-ft. and 3266-ft. levels is providing some interest to shareholders, for a new shoot of characteristic ore seems to have been discovered. The progress reports indicate a gold content of an ounce or more over 2 ft., with occasional widenings of the lode to 5 feet.

Malaya.—The fourth dredge of the Malayan Tin Dredging Co., operating near Batu Gajah, Perak, started operations in December. All four dredges were at work during January and the yield of tin concentrate was 108 tons.

Canada.—Detailed figures show that the mining industry of the Dominion grew substantially through 1915, despite war conditions. The non-metallic mines did not do quite so well as in the year 1914, as the domestic business revival did not come soon enough to mask the effects of the depression through the earlier part of the year. The silver mines, too, produced about one-sixth less than in the preceding year, though higher prices at the end stimulated production greatly. Iron and copper mining did better than ever before, zinc smelting was established, and the nickel mines worked up to capacity.

Though the Ontario Nickel Commission has not yet made its report, it is stated that arrangements are already being made for the building of a refinery in Canada by the International Nickel Company of New York. Presumably it will treat matte for metal for local consumption, and perhaps for export to Europe. As the larger part of the nickel sold by the company is used in the United States, where the company has an important refinery and where conditions are favourable for refining, it is to be presumed that the amount of nickel needed for use in that country will continue to be shipped in the form of matte. Any other procedure would force the development of other deposits by the International Nickel Company, and decrease the amount of work done at Sudbury, breaking Canada's monopoly. Just how important other deposits are is to be determined at first hand by the Commission. Mr. Willet G. Miller is now visiting Cuba for that purpose, and is to go to New Caledonia. Higher prices for nickel are anticipated, as present contracts will shortly expire and the demand is excessive.

Gold production in Canada is increasing rapidly and there is almost a boom in Northern Canada. Our Toronto correspondent gives details. In general it is becoming recognized that the area likely to reward careful prospecting is large, and that when the work is done intelligently and with persistence, the reward is reasonably sure to be large.

United States.—Production figures of the metals for 1915 are unusually interesting. California maintained, by a slight lead over Colorado, its position as the premier gold state, having produced \$23,005,800 to Colorado's \$22,191,200, while Alaska was third with \$16,626,700. Large outputs were shown in copper. Arizona had the tremendous figure of 450,000,000 lb.; Montana's total of 275,000,000 lb. was less than in several other years by reason of slackness at the beginning of the year; Michigan's figure of 259,352,000 lb. was its largest output, in spite of predictions that the Lake Superior mines had passed their zenith and that the late disastrous strike had seriously crippled the industry; Utah's rapid gain in copper during the past several years has been remarkable, the output in 1915 being 182,589,000 lb. The American copper output in 1915 was valued at $236,000,000, an increase of $83,000,000 over 1914. Zinc showed the greatest proportional gain. From domestic ores there was produced in the last year 460,000 tons, and a total of 490,000 tons worth $139,000,000, as compared with 353,000 tons worth $36,000,000 in 1914. That is, the value of the country's output of zinc more than trebled. Lead was only a little better than in 1914, the total from domestic ores being 516,000 tons worth $48,500,000 as compared with 512,794 tons worth $40,000,000.

California's claim as the greatest mineral-producing state in the Western States is not so much based on pre-eminence in gold production, its year's output of which was $23,000,000, as on the value of the petroleum produced. While the output of oil in 1915, namely, 89,000,000 barrels valued at $40,000,000, was smaller than in 1914 when 99,775,327 barrels valued at $47,000,000 was produced, the State's total mineral production for the year is estimated at over $95,000,000.

A significant move at San Francisco is the erection of a new antimony smelter by the Chapman Smelting Co., which has been producing 120 tons of 'star' metal per month from its present smelter. The present process of reduction in crucibles will be discarded in favour of reduction to the oxide and then to metal. Inyo and Kern counties are producing some antimony ore, which is shipped to the smelters at San Francisco and Los Angeles. As regards tungsten, the scheelite district of Atolia in southern California is gradually being extended as new discoveries continue to be made. Stealing of valuable tungsten concentrate, which is worth from a dollar to two dollars per pound, is a new form of 'high-grading.'

The long and bitterly contested strike among copper miners in the Clifton-Morenci district has been ended. The men win points as to price, but the companies win in the important matter of recognition of the Union. The men have given up their affiliation with the notorious Western Federation, which accordingly has another defeat to record.

Mexico.—The overshadowing feature of the month in Mexico was the massacre on January 10, not far from Chihuahua, of eighteen men returning to the Cusihuiriachic mines to resume operations. It was at first stated that included in the number were two British and one Canadian, but it is now believed that all of the men killed were Americans. The serious feature is that they were killed just because they were Americans, and in spite of assurances by the existing government that the country had been pacified and work might be resumed. The murders were committed by a remnant of the Villista army, apparently to provoke American intervention. The Carranza government has recognized the seriousness of the matter and sent men to pursue the rebels. A number said to have been concerned have been caught and executed. What the final outcome in Mexico will be is uncertain, but certainly this painful event has brought intervention nearer than anything happening in a long time. The American Smelting & Refining Co. has ordered locomotives and freight cars, and is preparing to resume operations at its smelting plants. The railroads, however, continue to be in the worst possible condition and the Mexican government has not yet recognized that it must ask the help of the bondholders to set things to rights. As we pointed out some weeks since, until this is done there can be little progress.

South America.—Conditions are rapidly improving in all the mining districts, and especially on the West Coast. The demand for nitrate outran the available shipping, and the British Government had to requisition a number of steamers in order to supply France and other Allies. Copper production is at capacity everywhere. The Société des Mines de Cuivre de Naltagua has ordered new smelting equipment, including reverberatory furnaces fired by powdered coal. According to P. F. Bliek and M. G. F. Söhnlein, who, in the *Engineering and Mining Journal* for January 22 give an excellent review of mining in Bolivia in 1915, the Corocoro United Copper Mines Co. has applied for permission to erect a smelter at Arica, the terminus of the new Bolivian road which is attracting a considerable share of the goods traffic from the interior. The Anaconda Copper Co. has acquired properties in both Chile and Bolivia. Messrs. Benjamin B. Thayer, L. D. Ricketts, and Reno Sales are now on a visit to the region and important announcements are anticipated on their return. The Anaconda has taken over the Andes Development Co. promoted by Mr. William Braden to develop the Potrerillos property in Chile. The Andes Copper Co., a holding concern with $50,000,000 capitalization, has been organized to control the Andes Copper Mining Co., and the Potrerillos Railway Co., the operating companies. An 80-mile line will be built. It is said that 40,000,000 tons of ore has been developed with 200,000,000 tons of probable ore, but no figures have been published officially.

At least one other of the large American mining groups is known to have acquired properties and several are represented by active agents. The American Smelting & Refining Co. is now buying Bolivian tin concentrate, and is making substantial cash advances against delivery, with returning charges about equal to those of British smelters. Freight rates also favour New York. The Oruro and Llallagua companies are selling to the American company, the Llallagua on a year's contract. Before the termination of that period the Llallagua company expects to have ready a plant of its own at some point on the Chilean coast, the Compania Chilena de Fundicion de Estaño having been organized to build and operate it. As this company is the second largest producer in Bolivia and as it ships more tin concentrate than the whole of either Cornwall or Nigeria, the importance of the move is apparent. The Llallagua company is owned by Chileans. There is also a proposal to smelt tin in Bolivia by electric power generated locally, but the project is in the hands of men less known and its future is uncertain.

Russia.—The Lena Goldfields meeting will be held shortly and is anticipated with much interest, as it is presumed that some announcement will be made regarding plans for working the lower grade gravels. Returns covering September 30 to November 30, old style, show 131,053 cu. yd. of gravel mined, 69,662 worked, and a gold yield of £153,383. The various returns made public from time to time indicate that the Lena had a good year and substantially increased its production. The Orsk, too, has done well, as we forecasted last month. Final figures for 1915 show a production valued at 696,000 roubles. The expenditure, including royalty, amounted to 327,500 roubles, and the profit from tributers was 40,000 roubles. Depreciation, London expenses, and profits taxes in both Russia and London are still to be deducted, but evidently shareholders will still have something substantial to divide. Bids are being taken for additional dredges for the Pavoda Estate in the platinum region.

We discuss at some length on another page the development of the orebodies at Kyshtim. Recent reports show that the Tuba, one of the prospects belonging to the Tanalyk Corporation, continues to develop well, and 80 ft. additional driving on the vein has just been reported ; it will be remembered that Mr. C. F. H. Leslie, the chairman, announced at the December meeting of the shareholders the finding of this important lode assaying over 70 dwt. in gold, with 24 oz. silver and a small amount of copper. The Irtysh project moves forward, and it is expected that the Ekibastus smelter will be ready to furnish spelter by the time the ice goes out of the river. Remembering that this plant has been built in the middle of the steppe in war time, where last May there was nothing but bare land, Mr. T. J. Jones and the engineers associated with him in its construction, have every reason to be proud of the result.

Notable Deaths. — E. P. Jennings, who died at Salt Lake City, Utah, in December, was long connected with American mining, particularly in the Lake Superior and Rocky Mountain regions. He was consulting engineer for the Highland Boy and various other Utah mines, a member of numerous technical societies, and an engineer of distinction and ability.

EDITORIAL

CANADIAN mining men have enlisted in large numbers and are serving with great distinction not only at the front, but in the equally necessary if less showy work of instructing men and preparing materials back of the line. Nevertheless they maintain their professional interests, as is shown by the attractive advance list of titles of papers to be offered at the meeting of the Canadian Mining Institute the first week of next month. Our good wishes go to them at this meeting and at all times.

AMONG mining men at the front recently honoured we note that the Military Cross has been awarded to the following officers of the Tunnelling Companies: Major T. M. Lowry, Captains Ralph Stokes, Cecil H. Cropper, and Lionel E. Hill. The same decoration has been won by the following men in other branches of the service: Captains B. H. Charlton and W. C. Hand, and Lieutenants E. C. Daniels, C. M. Euan-Smith, H. C. B. Hickling, Laurence C. Hill, H. R. Kerr, Herbert Eyden, and Stuart G. Love. In the Italian service a cross has also been awarded to Gelasio Caetani, who is now in the mining work on the Italian front. Our readers will recognize the names of many friends and rejoice in the distinctions won by them. We are all proud of the work that our mining men are doing at the front.

MASSACRE of eighteen American mining men in Mexico while travelling by train to the Cusihuiriachic mines in Chihuahua has caused intense feeling in the United States and especially in the West, where the murdered men were well known. While a strong feeling of disgust exists in America toward the flabby policy that at present apparently prevails in Mexico for the protection of foreigners, and while dissatisfaction is rife against the tolerant attitude of Washington, the better informed and more discerning Americans recognize in this last spectacular outrage merely a vicious attempt by the fast-disintegrating Villa forces to stampede the United States into war with Mexico, in which event the forbidding figure of Villa would loom as a national hero to lead his countrymen against the grasping invader. The controlling factor that restrains the Washington government from forceful intervention in Mexico is its firm desire to resist being pushed into a series of discreditable imbroglios with the Latin-American republics. Coupled with this is a certain idealism which may be admired in theory but which seems not to work out well in practice. The Carranza forces are after the bandits and have captured and executed some of them, but the stability of the Carranza regime is still to be demonstrated.

SECRECY in regard to technology has always had a strong opponent in Dr. James Douglas, who was recently and most fittingly honoured in the award of the John Fritz medal. In a note on the work of the great Canadian, Dr. Albert R. Ledoux relates, in the *Bulletin* of the American Institute of Mining Engineers, an incident that may well be taken to heart in these days when so much is being said as to British industries having fallen behind. We quote: "Dr. Douglas and I were visiting certain works at Swansea to inspect and report upon a patented process or machine, the inventor of which had the right to show it. We were hurried through the old-fashioned smelter, the proprietors evidently not wishing us to see anything except the particular apparatus which was the reason of our visit; but passing a small converter with which some men were tinkering, Dr. Douglas asked them what they were trying to do. With a little reluctance, they told him that they were trying to bessemerize a 37% copper matte, but that their experiments were unsuccessful because their charge continually froze. He asked them what was the pressure of air blast they employed. They said, so many ounces. He replied, 'No wonder you froze up! Give the furnace so many pounds.' The superintendent exclaimed, 'Why, if only a few ounces of air blown in freezes the charge, the same result would be hastened if we increased the pressure!' Nevertheless, they apparently tried it after we left, and when we arrived at our hotel in London, Dr. Douglas received a telegram from the works manager, telling him of their success and thanking him for his hint. Afterwards, he received a formal vote of thanks from the directors."

APPLICATION of the California Trona Co. for patent to certain lands in California, needed in connection with the development of potash works at Searles Lake, was denied. Though this affects only a small part of the holdings of the company, the judgment indicates a new attitude, and the establishment of new standards by the General Land Office. Probably in the end some amicable arrangement will be made between the Government and the company for the working of the deposits, seeing that the United States is anxious to be independent of Germany in the matter of potash supply. In somewhat similar cases in the oilfields, where good faith had been shown by the applicants, the department officials have shown a sympathetic attitude and have arranged for temporary leases pending final adjustment. The administration leasing bill was passed by the House of Congress recently, and it is hoped that before the adjournment of the present Congress a satisfactory law governing all such lands will have been enacted.

APPOINTMENT of Mr. Robert M. Raymond to the professorship of mining in Columbia University, made vacant by resignation of Mr. Henry Smith Munroe, has been announced. Mr. Raymond is another of that remarkable band of Canadians who found their first professional opportunity in the United States, and who have obtained such a prominent position there in mining and metallurgy. His own professional career has carried him into many lands, and in Australia, Mexico, and London, he is quite as well known as in Canada and the United States. We congratulate the University on the appointment, and Mr. Raymond on the opportunity. It is a great and a fitting thing that the schools can command the services of such men, and it is equally a cause for congratulation that the leaders in the active work of the profession are willing to translate into terms of active service their general interest in the young men who are to follow them. At Columbia H. M. Howe, Arthur L. Walker, and now R. M. Raymond, with William Frecheville, W. Gowland, and S. J. Truscott at our own School of Mines, to mention only a few of the names that come instantly to mind, form part of a growing number of engineers who have turned from an active and successful professional career to devote all or part of their time to training men for the future.

PROHIBITION has arrived in the Western States of America. The great mining states of Arizona, Colorado, Idaho, Oregon, and Washington are now 'dry.' The saloons that formerly dispensed whisky and beer to picturesque rough-booted and loud-talking assemblages of miners have now either closed their doors and hung a bit of crape thereon, or have taken to selling such stuff as is euphemistically known as 'soft drinks,' including ginger-ale, birch-beer, and milk-shakes. For the most part, the principal effect of the so-called reform by prohibition is to change the methods by which liquor is distributed to the consumers. It is only fair to remark, however, that engineers who have visited some of the new 'boom-camps' in prohibition districts, such as Oatman in Arizona, have praised the orderliness with its general absence of drunkenness and the manner in which money formerly consumed in excessive drinking is being put into prospecting.

Copper Prices.

Continued high metal prices have been the striking feature of recent months. During the second week in February the London price for standard copper crossed the £100 mark for the first time since 1907. That this is not owing to a local shortage due to disturbed conditions of shipping is shown by the fact that the London price merely followed that of New York, which is now the primary market. On every side the question is being asked, what does this mean? It can be stated with some confidence that it is not merely a result of orders for munitions. While the British Government wisely protected itself and the Allies by buying 120,000,000 lb. of copper in December, the movement is evidently broader. The mines of the United States are credited with producing 1,365,500,000 lb. of copper in 1915, as against 1,115,000,000 in 1914 and 1,225,000,000 in 1913. The exports for the first nine months of 1915 show that the gain in shipments to the Allies and neutral countries failed by 225,000,000 lb. to compensate for the loss in shipment to Germany and her associates in 1913, the last year before the war. The United States has shipped less copper than in normal times, and has produced more, and yet extremely high prices do not bring out any concealed surplus. This can only mean an enormous increase in local consumption, and that this is the correct explanation is indicated by studies of spelter and steel, two other metals that enter largely into general trade. It is worth remembering that the world's appetite for copper has been growing rapidly. In the decade before the war, despite an increase of 15% in the London price, the annual consumption of copper increased 55%, and it is to be presumed that this demand will continue to grow for some time. In the United States, where there is firm belief in high metal prices for at least a brief period after the war, there is perhaps some stocking of copper to meet that demand which the hopeful anticipate next autumn or by next spring at the latest. It has never been the custom in America to speculate largely in copper metal, and there is no well developed machinery for conducting such operations. While events have brought the copper producers closer together than in the past, we do not believe that manipulation enters in any large way into the making of the present price. Copper producers have found that the trade will pay more for metal if it must, and, seeing that to increase the output in any appreciable degree requires time and investment of sums beyond the reach of most, they plan to make it do so. We indicated last month how improved methods of treatment would make large amounts of additional metal available from existing mines, but it has also been shown that it is technically and economically feasible for production to be controlled even in the large units of operation now common. This new copper, therefore, is not likely to upset the market. The Americans have control of the copper market, and from the way they are going in for South American mining, they evidently mean to keep it. The British have an excellent start in Russia, the greatest known undeveloped field, and we should do well to hold it, as the maximum production outside America is not now large enough, nor is it likely to be for some time, to appreciably affect the world's prices.

Gold Production of the World.

We present in tables herewith our usual annual statement relating to the output of gold throughout the world. We have divided the figures into two sets, for in these days it is appropriate that the British Empire should have a table to itself. The European war has interfered less with the production of gold than of the other metals, and indeed it is possible to discuss the gold output from the point of view solely of mining conditions without any reference to the struggle between nations. Before going into details it is suitable to state the basis on which the figures are calculated. The statistics for most of the British countries are obtained from the monthly returns. The Canadian figures are the estimates of the Provincial Departments of Mines. No official figures for New South Wales, Tasmania, and New Zealand are as yet available, and we give figures based on official returns for previous years and modified according to later variations in the output of leading producers. Official statistics relating to the yield in British Guiana, Federated Malay States, British Borneo, and Egypt and the Sudan are also lacking, and our figures are deduced from previous records and reports of operating companies. The United States figures are the official estimates of the Bureau of the Mint and the Geological Survey. For the rest of the world, the statistics are in many cases difficult or even impossible to collect in London with any degree of accuracy, and where the results of our own efforts in this direction have not proved satisfactory to ourselves, we have relied on the figures provided by the *Engineering and Mining Journal*, whose editor, by his experience and sagacity, is a good judge in these matters.

PRODUCTION IN BRITISH EMPIRE.

	1914 £	1915 £
AFRICA:		
Transvaal	35,588,075	38,627,461
Rhodesia	3,580,207	3,823,166
West Africa	1,727,044	1,706,473
AUSTRALASIA:		
West Australia	5,237,300	5,140,200
Victoria	1,743,800	1,397,800
Queensland	1,027,300	1,078,500
New South Wales	529,000	562,000
South Australia	26,500	25,000
Tasmania	95,000	50,000
New Zealand	895,800	850,000
Total Australasia	9,554,700	9,103,500
INDIA	2,340,259	2,366,457
CANADA:		
British Columbia	1,063,110	1,265,000
Ontario	1,138,900	1,643,000
Yukon	1,052,400	975,000
Total Canada	3,254,410	3,883,000
FEDERATED MALAY STATES	50,000	50,000
BRITISH BORNEO	265,000	270,000
BRITISH GUIANA	210,000	215,000
EGYPT AND SUDAN	75,000	75,000
Total British Empire	56,644,700	60,120,000

REST OF THE WORLD.

	1914 £	1915 £
United States:		
Main Portion	15,790,000	16,586,000
Alaska	3,395,000	3,414,000
Philippines	225,700	264,300
Total United States	19,410,700	20,264,300
Mexico	3,634,000	3,280,000
Central America	718,800	770,000
South America	2,567,500	2,608,000
Russian Empire	5,500,000	6,000,000
Europe other than Russia	780,000	595,000
Japan and Korea	1,980,000	2,215,000
China	745,000	755,000
Madagascar	225,000	200,000
Congo	185,000	375,000
Dutch East Indies	648,000	670,000
Total	36,394,000	37,732,300
TOTAL FOR WHOLE WORLD	93,038,700	97,852,300

The total output of gold throughout the British Empire during 1915 was worth £60,120,000, as compared with £56,644,700 during 1914; and the world's output was worth £97,852,300, as compared with £93,038,700. The greatest gold-producing country continues to be the Transvaal, with £38,627,461, an increase of £3,000,000 over the previous year. The expanding activity in the Far East Rand promises to maintain the output of the Rand as a whole for several years before exhaustion causes some of the big mines in the Central Rand to fall out of the list of producers. Rhodesia with £3,823,166 shows a continuous rise, and probably there will be a further increase, though the ore reserves of many of the mines do not indicate an indefinite extension of their activities. West Africa with £1,706,473 has not quite held its own, and the rate of output is likely to remain stationary. In the Commonwealth, Western Australia remains fairly steady at £5,140,200, but the limited resources of the big Kalgoorlie mines threaten a serious drop during the next few years. The continued decline of Victoria as a gold-producer is an unfortunate feature of the tables. The passing of the Tasmania and the contraction of operations at Waihi account for much of the fall in the Tasmanian and New Zealand figures as compared with previous years. India pursues its steady course, and though the mines at Kolar are old and are worked at great depth, they appear to have much vitality left. In Canada, the Porcupine mines have augmented the returns from Ontario, and the figures for the Yukon and British Columbia are not greatly different from those of 1914.

The production in the United States shows a slight increase from £19,410,700 to £20,264,300. For convenience the returns are divided into those for the main continental stretch, Alaska, and the Philippines. Of the individual states the two largest producers, California and Colorado, both show increases. In California, the output was £4,724,000 as compared with £4,364,000 in 1914, and in Colorado, £4,610,000 as compared with £4,086,700. Of other states, Nevada produced £2,323,300, South Dakota £1,518,000, and Utah £717,500, the figures in each case not being greatly different from those of the previous year. The production in the Philippines shows a steady increase, and it is interesting to note that the activities are divided between American and Australian companies. The Mexican production is estimated by our New York contemporary at £3,280,000 as compared with £3,634,000. Judging by such information as is available in this country, these figures are higher than we should have expected. The figures given by our contemporary for Central and South America are not of great intetest, as the individual figures for Nicaragua, Colombia, Peru, Brazil, and French Guiana are not published. We have no definite figures for the Russian Empire, but feel justified in estimating that the output will be £500,000 greater than in 1914; in the future additional gold will come from the copper mines, but on the other hand, the exhaustion of the rich gravels of the Lena will cause a fall in the yield of placer gold. The output of Japan and Korea shows an increase due to greater amounts of gold being nowadays extracted from copper by the electrolytic refining process in Japan, and to the development of deposits in Korea. The gold mines of the Dutch East Indies are in the islands of Sumatra, Celebes, and Borneo. Of European countries, France and Hungary are both important producers, but reports indicate that operations have been curtailed.

The future of gold mining is good. The commercial upheaval caused by the war has served to emphasize the fact that the man who has got gold to sell is sure of his market. Though the gold mines suffer with others from the increased cost of supplies, labour, and transportation, and there is shortage at the mines as elsewhere of both men and equipment, the war conditions raise the value of the output. Where a choice is offered investors are the more ready, because of the war, to put money into gold mines. The fact that heavy taxes must be met in the future merely reinforces the necessity for security and large yield in making investments. In detail we note the growing interest in the Far Eastern Rand, which makes it possible that new mines will be brought into production there at a rate compensatory to the decrease on the Central Rand. That the gold ultimately to be mined from the East Rand is sufficient to keep up the output for many years is becoming more and more certain. No new fields of great promise are in sight at the moment, though expansion in Canada, Siberia, and the Philippines may be anticipated. Elsewhere increased yield must come mainly from more extensive working of low-grade ore, as at Juneau in Alaska, along the Mother Lode in California, and at Cripple Creek in Colorado, and the more extensive working of base metal mines from which gold and silver come as by-products.

Finding the Kyshtim Ore.

In a comprehensive and valuable discussion of the copper-bearing pyrite deposits at Kyshtim, of which we present a lengthy abstract in this issue, Mr. A. W. Stickney, geologist for the Kyshtim Mining Works, makes use of two principles worthy of especial note. The first is one that is recognized generally by economic geologists, but too seldom applied. It is little understood by engineers, particularly unfamiliar to laymen, and its significance is quite inadequately appreciated. The second has also been known in a general way to both mining engineers and geologists, but has only in recent years come to be used regularly by the latter. Mr. Stickney gives it a new application, one that if it prove sound may become most helpful, but one which, we feel bound to add, must be received with the greatest caution even in the case of the Kyshtim. The first principle is that the physiographic history of the region in which an orebody is found has influenced, and may well have determined, its character. It follows that this history must be read and interpreted if geology is to be of full service in development of the deposits, and even a tyro in geology knows that the physiography of the region must be learned by studies of the landscape over wide regions. The great flood of light thrown upon sulphide orebodies by studies of secondary enrichment has blinded more than one student, and too large a faith has been pinned to the presence or absence of particular minerals or rested on some other single minute criterion. The miner with his pick in the stope, and the petrologist with his microscope in the laboratory, have at times lost sight of the fact that ore deposits are geological material and that the study of their occurrence, form, and extent is a geological problem. Many years ago the late S. F. Emmons pointed out that to mining men developing an orebody the most significant geological phenomenon was the structure, and that remains true today. A favourable structure having been found, however, and the necessary minerals being present, the occurrence or non-occurrence of ore rich enough to ensure profit from working has been determined by the geologic history. In many instances, particularly those in which secondary enrichment enters into the problem, it is the recent geologic history which may be read in the land forms that is the determining factor. When the phenomenon of secondary enrichment was first recognized there was a scramble for deposits showing leached gossans. If, when one was found, a fortunate cross-cut or a well placed drill-hole showed sulphides below, matters were considered ripe for the formation of a new company. Later years have brought the sad knowledge that not every such association points to a profitable orebody. In the case of the Kyshtim, Mr. Stickney shows that the secondary enrichment that might well have added to the value of an orebody already sufficiently rich to be worked at a profit went astray, and that this was because of a change in the altitude of the land. Below the gossan, reflecting physiographic conditions long past, is a barite sand and what Mr. H. H. Knox designated an 'impoverished' zone. These, however, were formed under such conditions as lead to dissipation rather than concentration of the copper originally present, and this was due to the low-lying position of the orebody which brought the underground water level near to the surface. In our December issue we presented an abstract of a paper by Mr. J. J. Beeson, in which he showed how difference in surface slope, under otherwise uniform conditions, led to covellite enrichment in one part of the Bingham Canyon mines of the Utah Copper Company, while chalcocite enrichment characterized other parts. Mr. C. F. Tolman, Jr., and other writers have referred to physiography in studies of similar deposits, but the matter is generally inadequately treated by students of ore deposits. We are glad to be able to announce that as one part of the co-operative study of secondary enrichment being made for American copper producers by Mr. L. C. Graton and associates, Mr. Wallace W. Atwood is making special studies of the physiography of each deposit. It is a field capable, we feel sure, of yielding important results. The Kennicott mine in Alaska is one where the physiographic history might well have been taken into account. Those who have described this deposit have held that it consists of primary chalcocite, resting their conclusions mainly upon the absence of kernels of older sulphides in the slides examined microscopically; Mr. Waldemar Lindgren, for example, accepts this conclusion. Indeed so keen and experienced a geologist as Mr. H. V. Winchell has adopted a frankly sceptical attitude as to the probable importance of Alaskan copper mines, because of the cold climate and the probable removal through glaciation of any large bodies created by secondary enrichment. Our own visit to the region was entirely too brief to warrant more than a suggestion, but we may point out that the Kennicott mine occurs in a region which in pre-glacial times was long subjected to conditions favourable to secondary enrichment, and that it occurs above the limit of glaciation. To this may be added the fact that within the last two years, it is stated, the lower levels have shown the chalcocite to give place to leaner copper minerals, while a second bonanza has been developed in the adjacent Jumbo. There is danger in too narrow specialization and too limited study of a deposit.

The second principle of which Mr. Stickney makes unusual and significant use, is that orebodies vary in character from the centre to the periphery. This is an old fact of observation, and many instances can be cited. Miners who could not formulate a geological principle in technical language, none the less often become so intimately acquainted with the mode of occurrence of ores in a particular mine or district that they are able to recognize the beginning and end of an orebody with great certainty. We have known districts where the local miners were extremely skilful in extracting the heart of an orebody, leaving unbroken walls upon which to sell the mine to the unwary. Few of these men could explain the basis of their knowledge, but it is widely true, for example, that surrounding a body of mixed lead and zinc sulphides will be found very thin off-shoots, narrow veins in which little but clean galena occurs. In other districts magnesian enrichment extends wider than sulphide enrichment, and there are various other similar phenomena that the wise observer catalogues in his note-book. In his monumental discussion of the Butte ore deposits, Mr. Reno Sales interpreted this phenomenon, the zonal arrangement of the ore minerals, to be the result of the reaction of the country rock with a constantly outflowing stream of mineralizing solution. The first contact produced certain changes in both wall rock and solution, which made a second reaction possible. The zone so changed, becoming then inert to the first reaction, fresh solution passed on to fresh country rock. In time this produced the observed zonal arrangement in which sequence from the top downward, assuming no erosion, is duplicated from the side inward. The alternative and more common hypothesis is that solutions from the same magma, changing in character because of loss of material, heat, or pressure, are successively injected into the same rocks by repeated fracture. At Kyshtim, Mr. Stickney applies what may for convenience be called the Sales hypothesis. From studies of the orebodies he finds an increase in silica and alumina, and a decrease in iron and sulphur from the centre toward the periphery. At the Koniukhoff mine he found a similar change in the character of the ore with depth, accompanied in this instance with decrease in width of the orebody. We will not restate his arguments, but they permit him to predict with some assurance that the orebody will "approximate a vertical depth of some 2000 ft.," and that "in extension below the present deepest level (760 ft.) [it] should average at least as high in copper and higher in precious metals, with a little more silica and alumina, and possibly more zinc and barite than the ore above this level." This is a bold step out into the unknown, and Mr. Stickney evidently has the courage of his convictions. It is pleasant to record that after he had written this, a drill-hole penetrated the orebody at 1400 ft., and assays of the core fully sustained his prediction. At the same time one may fairly urge that the method be used with great caution. Mr. Stickney rejects the idea that the Kyshtim orebodies were formed by surface water flowing downward. If one tries to think of a central current of solution spreading outward as postulated by Mr. Sales for Butte, it is difficult to see how the zonal arrangement from the centre to the periphery comes to be reproduced from the centre downward. An enormous amount of solution would need to have been introduced into cracked and fissured schist, through an inlet so small as to escape notice, and not disturb the general symmetry of the orebody. This notion also involves continued flow of solution through that part of the orebody in which replacement of the country rock has been completed. Yet Mr. Stickney suggests, as part of the explanation for the non-enrichment of the orebody by secondary solutions from above, that they were unable to penetrate it because of its density, and wandered off into small fissures in the country rock. This whole matter of how ore-forming solutions enter the rocks that they replace, and how the unprecipitated part gets out, has been too little discussed, and much has been taken for granted. It is possible that where metasomatic replacement occurs, we should think of the orebody as a growing elliptical cone, or in other instances an irregular mass, and the mineralizing solutions as travelling, not through it and from the centre outward, but along the constantly shifting border between ore and rock. Replacement is seldom equal as to masses, and it would seem inherently probable that along such a border there would always be a certain amount of open space, even though it might well be finely divided. While the matter is open to debate, we are disposed to believe that the ore-forming solutions mainly travel through fairly continuous open spaces in rocks, rather than through the pores of the rock itself. It must be remembered that ores represent unusual concentrations of mineral; they are the incidental results, the by-products so to speak of nature's laboratory, and special agencies and conditions must constantly be called into requisition by the one who would explain them as a first step toward predicting them. Mr. Stickney has made excellent use of his material. He has found orebodies; possibly also he has found working methods of even greater value.

Spelter in the United States.

Unusual interest attaches to the American statistics of spelter production for 1915, since in that year the United States was the only important source of supply for those countries that depend upon imports. How this came about through the German conquest of the zinc smelting districts of Belgium, Northern France, and Poland, has already been related. It has also, we hope, been made clear that the shortage of spelter was due to a deficiency of smelters rather than ore, for at least three-fourths of the world's developed zinc mining capacity lies outside the German lines. At the beginning of the war the United States had considerable zinc smelting capacity lying idle. As soon as the scarcity of metal began to be reflected in price, all the unused retorts were set to work. At about the same time additions to existing plants began to be built, and long abandoned smelters were repaired and put into commission. Finally new plants of imposing size and capacity were erected. Upon what scale all this was done is indicated by figures collected for the United States Geological Survey by Mr. C. E. Siebenthal. According to him, there were 113,914 zinc retorts in the United States in commission at the beginning of 1915. By the mid-year the number had grown to 130,642, and by the end, to 154,898. That the movement is not yet ended, is indicated by the proposed extensions for 1916, amounting to 20,758 retorts, aside from a gas plant projected in Oklahoma, but with site and details unsettled. Furthermore, as we have already announced, the Anaconda Copper Company is at work building at Great Falls in Montana an electrolytic plant capable of producing 70,000,000 lb. of spelter per annum. There are still other developments in prospect such as electro-thermic smelting at Keokuk, Iowa, where the Consolidated Gold Fields is interested in a great hydro-electric plant and where experimental work in electro-thermic zinc smelting is in progress. Not all the American smelters now in operation are either modern or economical, and many of them must drop out of competition as soon as prices return to their normal level. It must not be forgotten, however, that in the main the new retorts have been put into existing plants run by experienced zinc smelting companies, and that the largest of the wholly new units, such as the Donora smelter of the Steel Corporation and the Great Falls plant of the Anaconda Company, are to the last degree modern and economical. They are also owned by companies which, by possession either of exclusive markets or abundant raw material, will be able to withstand the fiercest competition. Much of the new American smelting capacity must be considered permanent, and taken into account in any appraisal of future American competition.

Mr. Siebenthal finds that in 1915 the total production amounted to 490,000 tons of spelter, of which 460,000 was made from domestic ores. He gives the ore imports for the first ten months of the year as below, the figures being in tons of 2000 pounds:

Country	Ore	Zinc content	Value
			$
Australia	45,972	16,700	1,273,431
Canada	8,907	3,494	148,636
China and Japan	7.572	3,213	193,604
Italy	5 312	2,125	153,388
Mexico	49,694	14,521	1,610,270

It is evident that the United States is not especially dependent upon outside sources for ore. As a matter of fact it has enormous reserves of zinc ore capable of being quickly brought into production, all the more now that flotation and changes in smelting methods have made available the complex mixed sulphides of the Western States. The Joplin district, the great source of high-grade zinc ore, produced, according to Mr. Jesse A. Zook, the local statistician, 289,800 tons of blende ore and 22,500 of calamine, as compared with 254,500 and 29,700 in 1914. This is not a great increase when the jump in price is taken into account. Probably work done in 1915 will show in an increase of output for the present year, prices remaining the same, but it is significant that the production for 1915 is approximately the same as in 1910. The Joplin district holds its own, but cannot be expected to increase greatly. The areas still unprospected, however, assure its long life. In the West conditions are different. The Montana production has grown enormously and is followed closely by Colorado, Utah, and Idaho, while in British Columbia similar ores and conditions afford the basis for similar industry. The American smelters may continue to import ore, if it be economical to do so, but if the margin be unsatisfactory they can secure abundant domestic supplies.

It remains to inquire as to markets for the metal. In 1915 Mr. Siebenthal estimates the domestic consumption at 362,000 tons, which may be compared with 299,130 in 1914, 295,370 in 1913, and 340,341 in 1912. These figures give not only a measure of the American market, but indicate how much the revival of domestic business entered into the trade of last year. The exports of spelter and sheet zinc made from foreign and domestic ores amounted to 148,255 tons, to which should be added the increased amount of brass and brass goods shipped abroad. It would seem that, broadly speaking, despite the great increase in price, the American market absorbed spelter at about the maximum amount of recent years. We noted some months since that the rise in the price of spelter did not cut down the amount that was going into galvanizing trades *pari passu*. It is true that this was partly due to contracts ahead and *The Iron Age*, an excellent authority, states that many American galvanizers took heavy losses in the course of the year. The same journal estimates that production was at 25 to 35% of plant capacity at its lowest ebb in July and August, increasing to 50% by the end of the year. For purposes of comparison it may be pointed out that in the United States the whole steel industry operates from time to time at but 50% to 80% of the plant capacity. The added cost of galvanizing began to be passed on to the consumer in the course of the year, sheets nearly doubling in price, though spelter only accounts for some 16% of the weight of the goods. The noteworthy fact is that with industry at normal rate of production the market will absorb nearly its usual amount of spelter for galvanizing at a considerable advance over normal prices, and the galvanizers take about half the spelter output. There is another fact properly to be taken into account, and that is the increased consumption of spelter the world over. In the decade closing with 1913, the last year before the war, this increase amounted to 60%. It is also notable that the world is willing to pay more for spelter as the years go by. Plotting prices for the last quarter of a century shows that there are periods of high prices at intervals of four to five years, and with low prices between. Each high price, save that of 1903, rises a little above the one before; and each low fails by a little to touch the last preceding low. Disregarding the influence of the war there should normally have been a high sometime in 1916 with spelter at perhaps £37 in London. This fluctuating curve represents the effort of production to overtake consumption, but with abundant ore and capital for new plant production is brought in at each rise in price, faster than the demand for metal grows. Zinc is widely distributed, and zinc ores are not readily recognized, especially the carbonates, while zinc has been so long penalized in lead, copper, and precious metal ores that prospectors have come to avoid it almost by instinct. The result is that miners who know zinc can always find deposits when the price warrants; relative to better known metals the supplies are less exhausted. There must sometime be an end to this, but that time is long in the future. How far the other factor, the amount of capital available for mining and smelting zinc, will be influenced by the war is a different matter. At another time we purpose to discuss this, as also the zinc industry in countries outside the United States. From that country the world may expect a generous output of spelter for an indefinite period, even at prices materially below those that have ruled for the past year.

PYRITIC COPPER DEPOSITS AT KYSHTIM

By A. W. STICKNEY.

The author, who has studied the deposits for three years and has had the benefit of notes collected by H. H. Knox, H. W. Turner, and C. T. Brodrick, interprets the orebodies as pyritic replacements formed at intermediate depths by hydrothermal metamorphism following the last regional metamorphism. He finds a certain mineralogical variation from the centre outward horizontally and a similar variation vertically which he uses as a basis for prediction as to extent and grade in depth. The gossan is considered to have been formed by normal weathering under topographic conditions favouring active underground waters. The lower lying baritic zone represents actions when relief was slighter and underground flow sluggish; when the waters carried below underground water level enough oxygen to convert sulphides to sulphates, but not to fix the iron as limonite. For reasons given secondary enrichment is unimportant. Readers of the Magazine will recall the article on 'Copper Mines of the Ural Region' by H. W. Turner, printed June 1912.

*THE pyritic copper orebodies are confined to one of the longitudinal portions of a great belt of uralite schist interbedded or intercalated with the ordinary metamorphosed sediments and forming a marked geological feature of the Kyshtim district. The orebodies are found where the rock has been largely altered to zones of a thinly foliated, fissile, chlorite and epidote schist. It might be possible to regard this longitudinal portion of the schist belt with a length of eight miles as a lode, in which the orebodies form ore-shoots.

The orebodies are arranged in series in this belt with two exceptions: the Smirnoff West and East veins and the West and East veins of the Ivanoff. In these instances the orebodies are arranged *en echelon*, when viewed in horizontal plan, and on roughly parallel lines separated in the former instance by about 110 ft., and in the latter by 220. The longitudinal interval along the schist belt between successive orebodies arranged in series varies from one-fourth mile to two miles. These serially arranged orebodies generally do not lie on the same zone within the schist belt. In form the orebodies present an elongated, somewhat lenticular appearance in horizontal section. They either wedge out at a single point or divide up into a few closely spaced, tapering stringers at their extremities. Full data bearing upon the vertical variation in form or shape of the orebodies below the zone of impoverishment are not available, but in general the deepest workings and drill-holes suggest a gradual narrowing in depth, accompanied probably by a small decrease in length. The several orebodies show a difference in size, as attested by the dimensions given in the table below, the orebodies being enumerated in their order from north to south.

If the Ivanoff veins are omitted, the orebodies approximate a size affording to the present average depth proved by drilling a tonnage of a million tons each. The vertical range of ore deposition appears to have been great compared with its range in the other dimensions of the orebodies. The massive sulphide ore attains its maximum average width near the surface and shows only a very gradual and regular tapering with increasing depth. At none of the orebodies does the sulphide ore taper upward, and no blind veins have been found where there is no outcrop, notwithstanding the fact that the mineralized schist belt at the orebodies and over the extension between the several orebodies has been fairly exhaustively tested, at vertical depths ranging from 150 ft. to 500 ft., by diamond drilling. Not only then is the present vertical depth proved to be consider-

* Abstracted from an article in *Economic Geology*.

DIMENSIONS OF OREBODIES AT KYSHTIM.

Orebody	Length, Ft.	Max. Horiz. Width, Ft.	Dip to East Deg.	Present Vert. Depth Opened up by Deepest Mining Operations, Ft.	Present Vert. Depth Proved by Drilling, Ft.
Koniukhoff	900	35	60	760	1400
Smirnoff:					
West vein	900	28	55	580	660
East vein	750	20	60	580	500
Americansky	800	23	57	200	740
Tissoff	1500	90	70	400	920
Ivanoff:					
West vein	300	Unknown	68	None	550
East vein	260	Unknown	69	200	380

able, without limiting the orebodies except at the Ivanoff, but the above facts suggest that erosion has determined what will be found to be the vertical extent of the orebodies in the field. Furthermore, the geologic and topographic history indicates that post-mineral denudation has been great, and the conditions existing at the Ivanoff appear to indicate that an important portion of the orebodies has been removed by erosion and lost.

The orebodies invariably conform in dip and strike with the schistosity of the enclosing wall rock. None of the individual veins show the marked and abrupt changes in strike or dip, or the splitting up into many lenses which are so frequently present in orebodies in a schistose wall rock when the mineralization preceded the dynamo-metamorphism. The vein walls are generally well defined, relatively sharp, smooth, and straight, but marked by no clay selvage or gouge. They show no evidence of having been planes of movement either before or after ore deposition. The immediately adjacent wall rock, however, shows intense sheeting accompanied probably, though very locally, by what appears to be some brecciated structure.

The orebodies are composed predominantly of a homogeneous mass of granular pyrite and are remarkably free from admixed wall rock. Enclosed horses of the typical chlorite and epidote schist pyritized and altered to sericitic schist occur with the planes of schistosity parallel to that of the wall rocks, but are small and unimportant. They show a remarkable persistence in the vertical plane and a steep pitch parallel to that of the orebodies. Post-mineral faults with notable displacement do not occur so far as at present known. That some slight movement, probably in the form of a general regional settling, has occurred since ore-deposition is shown by the joints which traverse the ore.

THE OREBODIES. — The orebodies normally show four well developed and roughly horizontal zones as viewed in a vertical longitudinal projection or cross-section. From the outcrop down they may be designated as: *(a)* the gossan zone which extends from the surface to a maximum depth of 40 ft.; *(b)* the zone of loose baritic sand with a locus lying from the bottom of the gossan to a maximum depth of 200 ft.; *(c)* the loose 'impoverished' sulphides* which extend from the bottom of the baritic sand to a maximum depth of 240 ft. where they gradually pass into *(d)* the underlying firm, massive, mainly unaltered, and primary sulphide ore.

Several salient features are apparent from a study of the relations of size and shape of orebodies to depth and groundwater. Notable among these are: *(a)* the close parallelism of the several zones to the upper surface of groundwater; *(b)* the intimate relation of the depth of the groundwater level to the vertical range of the several zones; *(c)* the sulphides at the several orebodies do not begin, even approximately, at the same elevation above sea level; *(d)* the gossan in general ends short of the groundwater level and has a width about two-thirds that of the firm massive sulphide ore; *(e)* the baritic sand for the greater portion lies beneath the upper surface of the groundwater and has a width less than that of the overlying gossan and practically one-fourth that of the firm massive sulphides; *(f)* the impoverished sulphides are some two-thirds as wide as the underlying firm, massive ore; *(g)* the sulphides do not occur until a depth varying from 25 to 95 ft. below the groundwater level is reached; *(h)* leaching with impoverishment in copper persists to a depth varying from 50 to 135 ft. below the groundwater level; *(i)* the non-occurrence of a definite zone of gossan at the Ivanoff orebody where the greater topographic relief is more favourable to denudation than at any of the other orebodies.

The normal outcrop of the orebodies, which does not rise above or is not depressed below the country, is a gossan, brick red to yellowish, porous, honey-combed, a fairly well cemented aggregate of limonite and perhaps other hydrous iron oxides in smaller quantity, barite, quartz, and kaolinite, decreasing in abundance in the order named. The barite and quartz form a network of small grains exhibiting the skeleton frame of the firm sulphide ore and held in place by casts of limonite which, with a little clayey material, partly fills the moulds of the former sulphides. The sulphur, originally combined with the iron, copper, and zinc in the primary sulphide ore and amounting to some 45%, has been almost completely removed in the gossan. In no instance has it been found to exceed 0·7%. Iron, which averages about 38% in the sulphide ore, has suffered little or no removal. The zinc, which averages about 2·5% in the primary ore, never exceeds 0·3% in the gossan, while in general only traces remain. Copper does not show as complete a removal as the zinc. It varies from 0·1 up to a little over 1%, the quantity present

* A term introduced by Mr. Knox to designate sulphide ore which has been leached of its copper content without oxidation of pyrite. *Trans. Inst. Min. Met.*, Vol. XVIII., 1909.

THE PARK COUNTRY IN WHICH THERE IS GREAT DIFFICULTY IN PROSPECTING THE DEPOSITS.

varying independently of the depth of ground-water level. The copper is present mainly as malachite with which is associated a smaller amount of azurite and cuprite. Impoverishment in zinc and copper is regarded as the result of the strong sulphate water formed by the oxidation of the sulphide ore and the absence of appreciable quantities of calcite or other carbonates in the ore or immediate adjacent country rock, which would tend to precipitate the carbonates of copper and zinc. The gold content averages around 0·25 oz. per ton (the ton of 2240 lb. is used throughout this article), and in maintaining the same ratio to the barite and quartz as exists in the primary sulphide ore appears to show only a relative

AN IRON MINE IN THE TIMBERED COUNTRY AT KYSHTIM IT IS EASIER TO PROSPECT LAND OF THIS TYPE.

enrichment by solution and removal of the sulphur, copper, and zinc. According to present ideas, this condition would be expected as the ore carries no manganese. Silver, however, in averaging 3·5 oz. in the gossan shows more than residual enrichment.

The gossan with depth gradually decreases in width, and as barite and quartz gradually increase and limonite decreases, passes, with a transitional zone some 10 ft. in vertical extent, into the zone of loose baritic sand, in one of the orebodies at the groundwater level, in the others above this horizon.

The baritic sand zone consists predominantly of loose grains of barite and quartz, which constitute some 80 to 90% of the material and do not show the skeleton frame of the firm sulphide ore. These grains are generally stained by limonite, but the quantity of iron present will not average over 8%, which is less than one-fourth the amount in the gossan, and often the sand is so thoroughly leached that less than 1% of iron remains. Sulphur, copper, and zinc in the average have been almost completely removed by leaching. Gold and silver show only residual enrichment, with the former averaging 1·3 oz. and the latter 13·5 oz. The precious metals are present in such minute flecks that they cannot be recovered by panning. The sand has an average specific gravity of 3·3. The striking characteristic of this zone is the broken, caved, and settled condition of the adjacent hanging wall. This does not occur in the gossan zone —at least not in a similar degree of development. In the lower part of the zone of baritic sand the width decreases noticeably over a few feet in vertical extent, a phenomenon followed immediately by the appearance of a few scattered, loose, and corroded grains of pyrite, and an increase in the width of the vein. As these grains of pyrite continue to increase in amount and the quantity of barite and quartz gradually decreases, there is a progressive change with an increase in the width of the vein, through a transition zone some 10 to 20 ft. in vertical extent, into the typical loose impoverished sulphides.

The impoverished sulphides consist of an incoherent aggregate of pyrite grains with which occur a smaller number of grains of barite and quartz. In this zone, where leaching has presumably been most recent, a number of small open spaces or voids exists where the settling of the hanging wall schist has not yet occurred. These open spaces are generally localized to the hanging wall portion of the vein.

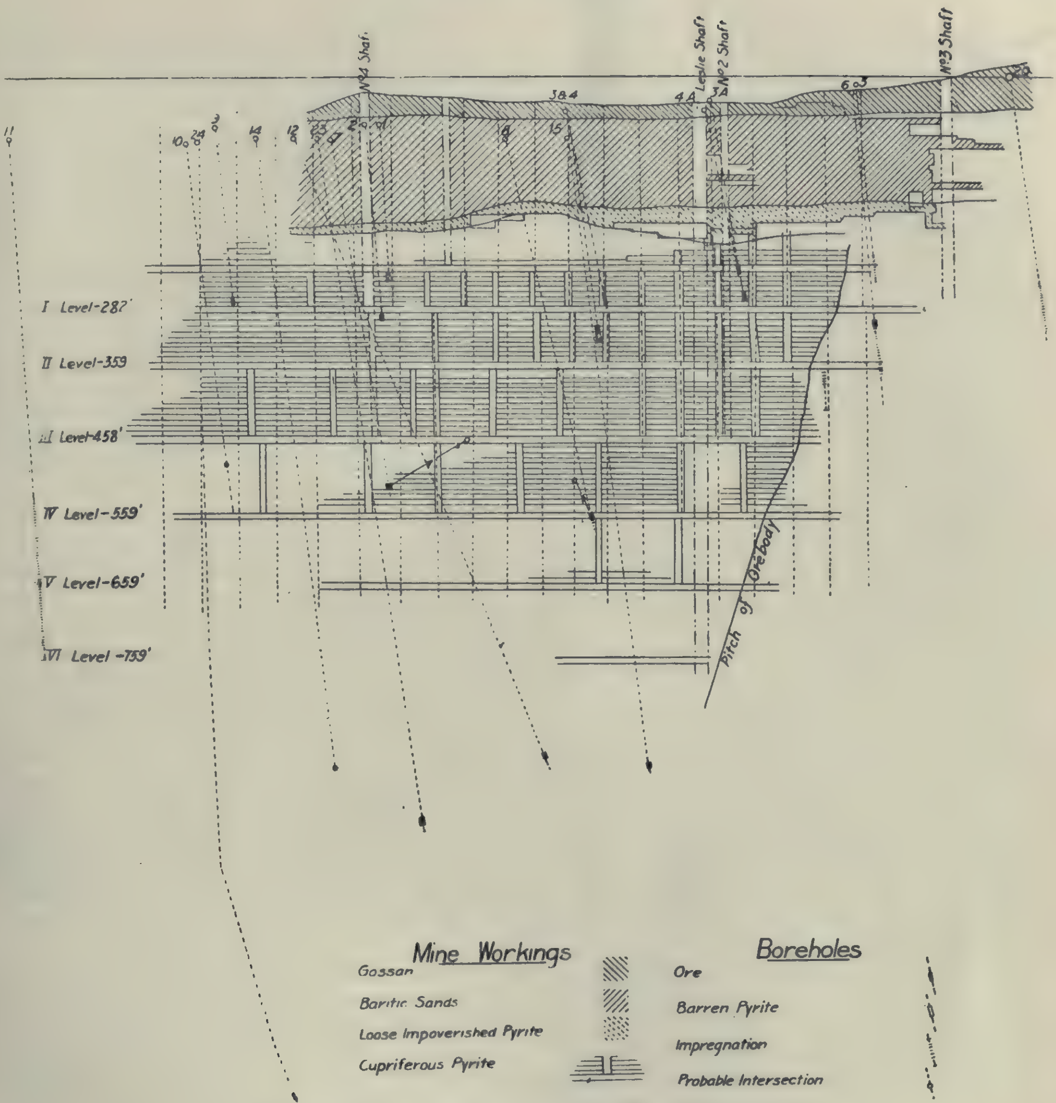
The width of the vein shows a continuous increase with depth in this zone. The constituent grains become more and more coherent; the copper and zinc contents progressively increase with depth; the gold, silver, barite, and quartz decrease, and the material passes with increasing depth into a low-grade (1 to 2%) copper ore which crumbles only on exposure to the air; and finally into the underlying firm, mainly unaltered sulphide ore. The impoverished sulphides persist to a slightly greater depth next to the walls than in the medial portion of the orebodies.

The typical primary sulphide ore is a compact, dense, relatively fine-grained, massive aggregate of cracked and sheeted granular pyrite (grains 0·01 to 0·1 inch in diameter), barite, and fibrous quartz with a few shreds of sericite and chlorite, carrying irregular blotches and streaks of chalcopyrite and sphalerite and minute interstitial grains of tennantite. All the above minerals with the exception of the minute quantities of sericite and chlorite, and probably a small part of the quartz, occur in typical primary intergrowth. The latter appear as remnants left in the ore. The ore contains a much greater proportion of metallic sulphides than of non-metallic gangue and has a specific gravity of 5·5. The average composition of the massive sulphide ore for all the orebodies, except the Ivanoff veins, is as follows:

	Per cent.
Cu	3·5
Fe	38·0
S	45·5
Zn	2·5
Pb	0·2
As	0·5
$BaSO_4$	5·5
SiO_2	2·0
Al_2O_3	1·0
CaO	0·5
MgO	0·5
	99·7

Gold ....0·12 oz. per long ton
Silver..................1·2 oz. per long ton

The massive sulphide ore shows banding, very faintly developed at the longitudinal middle portion of the orebodies where the clean, hard massive pyrite carries a minimum of copper, zinc, gold, and silver, but particularly pronounced toward the longitudinal extremities of the orebodies where the ore is generally richer in the above metals and carries a greater proportion of non-metallic gangue. An individual band ranges from a small fraction of an inch to several inches in thickness and is differentiated from the contiguous bands into which it grades by its colour and, to a less degree, by texture. This difference is the



LONGITUDINAL SECTION OF THE KONIUKHOFF MINE.

result of a variation in the relative quantity of tennantite, sphalerite, or chalcopyrite, and in a minor degree to variations in the amount of non-metallic gangue. The banding invariably is parallel to the vein walls and the schistosity of the enclosing rock. A single band shows a greater persistence vertically than longitudinally. There is no crustification.

Critical observations of the mineralogical character of the ore in any of the bodies, as it is exposed on a given level, suggest that as one passes from the middle portion toward the extremities of the orebodies, the massive sulhide ore exhibits a progressive increase in the quantity of non-metallic gangue (silica, alumina, or barite), and a corresponding decrease in the amount of pyrite. These observations have been confirmed in the instance of the Koniukhoff orebody by chemical determinations made upon a series of relatively large samples taken at 25-ft. intervals horizontally along the extent of the orebody. Similar variation is suggested from the analyses of the cores obtained from the diamond drilling done in proving and developing the Americansky.

These two orebodies have a somewhat different form. In the one case, the Americansky, the orebody reaches its maximum width near its middle and wedges out at both ends; while the Koniukhoff tapers out at the northern termination but presents a broadening at the southern end. All the orebodies have one or the other of these two forms, and it appears that the longitudinal variation in the composition of the ore is independent of the shape of the orebody.

The following conclusions have been drawn from a study of the analyses mentioned: *(a)* The iron and sulphur content, representing mainly pyrite, is at a maximum at a locality near the longitudinal middle of the orebody and progressively decreases toward the two ends; *(b)* silica and alumina are at a minimum where the pyrite has its maximum development and increase toward the extremities of the orebody; *(c)* pyrite is developed in largest quantity near the longitudinal middle portion of the orebody, indicating very complete replacement of the schist, and progressively gives way toward the ends to increasing quantities of silica and alumina, which at least in part represent unreplaced residuum, suggesting progressively less complete replacement of the schist toward the extremities of the orebody; *(d)* gold and silver are at a minimum in the ore near the middle portion and increase somewhat progresssively toward the extremities of the orebody; and *(e)* the copper and zinc in the ore are relatively low near the longitudinal middle of the orebody, attain their maximum in the end portions, and in general do not fall below the ore minimum until the combined silica and alumina content reaches approximately 20% at the extremities of the orebody where the copper and zinc fall off rapidly. While the limitation given does not appear in the tabulations, it was suggested by a number of critical determinations.

The Koniukhoff body, at which the present mine workings as well as the diamond drilling has reached the greatest depth, was studied for the purpose of determining whether there might be a vertical variation as well as this longitudinal variation in the composition of the orebody. The important facts learned were that there is: *(a)* a gradual and regular decrease in the average width of the orebody with depth, and *(b)* a decrease in pyrite accompanied by an increase of gold, silver, quartz, and aluminous material with increasing depth, while an increase in barite and zinc also appears to be indicated. In other words, a progressive decrease in width and change in relative composition of the ore with depth on a vertical section, similar in general to the variation occurring in the horizontal plane from the middle of the orebody outward, is at least strongly suggested. There may thus prove to be some significance in these observations bearing upon the depth to which the orebody will persist.

The rate of decrease in width and variation in composition of the ore with increasing depth as compared with the similar phenomena in the horizontal section may suggest that the orebody will approximate a vertical depth of some 2000 ft., before tapering or fingering out into a zone of pyritized and silicified schist. Furthermore, these relations appear to suggest that the ore in the extension below the present deepest level (760 ft. vertical) should average at least as high in copper, and higher in the precious metals, with a little more silica and alumina and possibly more zinc and barite than the ore above this level.

At all the orebodies, so far as they could and have been studied at present, the ore appears to show longitudinal and vertical variations similar to those given above. The Ivanoff orebodies, however, appear to have been limited by diamond drilling to a vertical depth less than 600 ft., below which each vein is represented by a zone of highly silicified and pyritized schist. Nevertheless the diagnostic criteria indicate that these two veins are of the same type, were formed in the same mineralizing epoch and under the same conditions as the other orebodies. It is believed that the present Ivanoff veins represent orebodies corresponding in size with the other orebodies of the district but now largely removed by erosion.

PARAGENESIS.—Microscopic study of the massive sulphide ore indicates that alternating bands of the sheeted and strongly foliated schist were first metasomatically replaced by an usually rather coarse-grained, cracked and sheeted pyrite, anhedral barite, and fibrous quartz, leaving minute bunches and shreds of chlorite and sericite which were later in the process replaced by chalcopyrite, sphalerite, and tennantite, which themselves are contemporaneous. Tennantite also probably marks a still slightly later stage in the primary mineralization and with it are contemporaneously associated chalcopyrite and quartz. In some of the orebodies analyses indicate that high precious metal values in the ore are associated with the occurrence of tennantite, but in others this does not appear to hold. There is, then, a decreasing iron, increasing copper content of the minerals successively deposited.

ORIGIN OF THE ORES.—In the absence of: *(a)* evidence indicating that the veins have suffered squeezing into a series of imbricating lenses, *(b)* the development of dynamo-metamorphic minerals in the ore or sericitized wall rock, and *(c)* evidence suggesting a straining of the quartz grains in the ore, it is concluded that the ore deposition occurred after the last dynamic metamorphism.

Bearing upon the genesis of the orebodies the following facts have been brought out: *(a)* a gradual transition from the clear massive sulphide ore (locally almost entirely pyrite) near the longitudinal middle portion of the orebodies, through the somewhat schistose ore at the extremities of the bodies, into the zone of silicified and pyritized rock; and the presence of numerous fairly persistent bands occurring throughout the schist belt where the typical schist has been impregnated with the sulphides of the orebodies; *(b)* the retention in the ore, in the form of banding, of the schistose structure of the enclosing rock; and *(c)* the presence within the orebodies of horses of the typical wall rock schist which have their schistosity parallel to that of the enclosing wall rock. From this evidence it follows that the orebodies do not represent the filling of cavities, but metasomatic replacements of the country-rock.

Among the conditions that may have caused the distribution of the orebodies, and determined the degree of replacement of the schist by sulphides, it appears that variations in the original composition of the schist were not important. A consideration of the longitudinal variation in the composition of the ore in the orebodies, and the relation of this to the degree of banding in the ore, together with the paragenesis of the ore minerals, suggest that these several phenomena are all intimately related. It appears probable that a locus of maximum permeability and, therefore, maximum mineralizing action occurred in the thinly foliated schist zone near the longitudinal middle portion of the orebodies where the pyrite which was first deposited nearly completely replaced the schist, rendering this portion relatively impervious to the action of the solutions characterizing a later period in the mineralizing epoch and richer in gold, silver, zinc, and copper. The ore in this portion of the orebodies, therefore, consists more predominantly of pyrite and naturally preserves very poorly the banding of the schist, since the banding of the ore is the result of a partial individualization in parallel seams of the various ore minerals by the metasomatic replacement of successive bands of the schist by solutions varying in composition. Outward, toward the longitudinal extremities of the orebodies, the zone of thinly foliated schist was less and less permeable and was not so completely replaced during the early stages of the mineralization, but bands were left to be replaced by the solutions characterizing the later stages; thus the structure of the schist was better preserved. The richer ore is invariably the most pronouncedly banded, and vice versa.

Relative Chemical Composition of the Several Zones. — The essential features shown by a chemical study of a particular block in the northern portion of the Americansky orebody may be summarized as follows:

1. The clean gossan carries from 0·10 to 1·3% copper, but in every instance carries more copper than the underlying baritic sand or the loose sulphides. The bottom of the gossan zone carries less copper than the outcrop.

2. The gossan carries four times or more as much iron as the immediately underlying baritic sand.

3. Barite, silica, and in general alumina maintain a fairly constant ratio throughout the several zones, and the proportions present depend upon the amount of iron and sulphur removed and show only residual enrichment.

4. Gold maintains in general a different ratio to the barite and quartz throughout the several zones and shows only a relative enrichment by solution and removal of the other constituents of the original ore. The same can be said of silver, the ratio of gold and silver remaining practically constant, except in the upper portion of the gossan zone where a positive enrichment in silver is indicated.

5. There is nothing to suggest that descending meteoric waters have dissolved and transported any of the barite, quartz, or gold.

6. There is a gradual transition from any one zone into another.

7. The absence of a well developed and well defined zone of downward secondary sulphide enrichment.

In considering the probable genesis of these several important superficial zones, unique in their degree of development, a number of features are important: (*a*) the physical character of the gossan; (*b*) its chemical composition relative to the underlying zone of baritic sand; (*c*) its comparative width with the relative absence of a broken hanging wall as contrasted with the settled hanging wall in the zone of baritic sand; and (*d*) the presence of this broken and caved hanging wall at the surface in the instance of the Ivanoff where the baritic sand outcrops. All of these features point to the conclusion that the gossan is the result of normal processes of oxidation acting upon the massive sulphide ore. There is no evidence to support the hypothesis that the gossan was formed from the baritic sand by iron sulphate solutions generated in the zone of loose, leached sulphides, then ascending through the extensive zone of baritic sand, and finally having the iron fixed as limonite near the surface in the baritic sand by descending surface waters heavily charged with oxygen. There is nothing to suggest that gossan is being formed at the present time. It is inferred that all the gossan is a remnant of that formed at a previous period and not as yet removed by erosion except in the instance of the Ivanoff where topographic conditions appear to have been and are now favourable to more rapid denudation. It is believed that during a period in the past the rate of denudation has been much greater, the result of a much steeper gradient in the younger topography, and the massive sulphide ore was kept so near the surface (that is, above the groundwater level) that an excess of oxygen was always immediately ready to convert the iron of the ferrous sulphate formed into limonite. Since then these conditions gradually have ceased to exist owing to long continued erosion.

As long as the rate of denudation kept the groundwater level lowering faster than descending oxygen-charged surface water could convert into limonite the massive sulphide ore being brought above the water level, the water reaching this level had lost its oxygen. When, however, as the rate of erosion gradually decreased, and the gossan finally reached the groundwater level, then the surface water descending along the previous channel formed by the porous gossan would still be charged with oxygen on reaching the water level. It, therefore, was able to attack the massive sulphide ore. Then, at this depth, it dissolved first the copper and then the iron as sulphate. Owing to the much slower movement of this water and its tendency to diffuse and mingle with the rest of the groundwater, there was not sufficient oxygen supplied to accomplish complete oxidation and precipitate the iron as limonite. The copper and iron sulphates were lost through diffusion into the body of the groundwater, a tendency accentuated by a wall rock which is more permeable than the firm massive sulphide ore.

At first, the copper being attacked before the iron, a zone of loose leached sulphides, corresponding in character to the present zone existing at greater depth, was formed at and immediately below the groundwater level. Since the water level was gradually lowering, some of these loose, leached sulphides came above groundwater before much of the iron had been leached, and naturally what iron remained as sulphide was then converted to limonite. This gave rise to the transition zone of sandy gossan lying between the typical gossan and the baritic sand. By this time the water level was lowering very gradually, and as the leaching process going on somewhat below this level was leaving behind it in the vein a very pervious zone for water circulation, it kept gaining on the depression of the water level, until finally the material remaining at the water level was very thoroughly leached of its iron, the baritic sand.

In the continuation of this process over a long period the results naturally would be an horizon of typical gossan, in part or wholly removed by erosion, and ending short of the groundwater level. This is followed in depth through a transition zone of sandy gossan, by baritic sand, which in turn gives way to loose leached sulphides; and, finally, the firm massive sulphide ore. And these are just the conditions found.

The following factors are believed to have an important bearing on the process: *(a)* as leaching proceeds, a ready channel for circulation of water is left behind; *(b)* at the bottom of the leaching zone the water which has descended down the pervious vein channel above finds the massive sulphide ore more impervious than the enclosing wall rock and, therefore, largely diffuses into the groundwater, leaving the firm sulphide ore with an upward convex surface; and *(c)* there is both a vertical and horizontal circulation in the upper portion, at least, of the groundwater, which is not so stagnant as some have supposed. This last factor is further emphasized in the paths followed by what downward secondary sulphide enrichment has occurred.

DOWNWARD SECONDARY SULPHIDE ENRICHMENT.—This does not occur in the form of a thin, well developed and commercially important horizontal zone at the top of the primary sulphide ore, but has taken place to a relatively slight degree along the wall portions of the orebodies in decreasing amount to a depth at least 600 ft. below the upper surface of groundwater. At this depth in bands a few inches or less in width localized to the lateral portions of the veins and along cracks and joints in the massive primary ore, secondary chalcocite, covellite, and zinc sulphide are found replacing the primary sulphides.

SUMMARY.—The massive primary sulphide ore shows a progressive longitudinal variation in relative mineralogical composition from a locus of maximum intensity of replacement by pyrite near the central portion of the orebody outward toward the extremities. A similar variation is indicated in the vertical plane from the upper portion of the massive sulphide ore downward.

The gossan is regarded as the result of normal processes of oxidation acting upon the massive sulphide ore above the groundwater level. The baritic sand and loose impoverished sulphides are believed to be the result respectively of complete and partial leaching beneath the upper surface of the groundwater by descending surface water charged with oxygen but too diluted and diffused to produce complete oxidation and fix the iron as limonite, the iron sulphate and much of the copper sulphate generated being lost through diffusion into the more permeable wall rock.

The character and mineralogical composition of the ore, the nature of the hydrothermal alteration, and the relative physical characters of the adjacent wall rock indicate that the deposits have been formed subsequent to the last regional metamorphism through metasomatic replacement of the schist along sheeted and more intensely foliated zones; and that the replacement of the schist took place band by band, during a distinct mineralizing epoch, by solutions progressively changing in composition and depositing a series of sulphide minerals in the order of decreasing iron, increasing copper content, and thus preserving the original banding of the schist by a difference in the relative proportions of the several ore minerals in bands successively replaced. It is believed that the progressive longitudinal variation in the composition of the massive sulphide ore indicates that a locus of maximum mineralizing intensity occurred near the middle portion of the orebodies; and that the somewhat similar vertical variation suggests that this locus continues downward. In the absence of minerals characteristic of the other zones of ore deposition in the ore or adjacent altered country rock, and the presence of sericite, barite, and quartz it is concluded that the mineralization was effected by hot alkaline solutions at a temperature and pressure corresponding to what Waldemar Lindgren calls the intermediate depth.

Madagascar Minerals.

Gold is nowhere abundant, but being widely distributed, particularly along the eastern side of the island, important quantities are obtained in the aggregate, a fact that has given rise to the erroneous impression that Madagascar is a rich gold country. The deposits are of too poor and patchy a character to be worked profitably otherwise than at present upon a sort of tributing system. There may be exceptions where hydraulicking or dredging would pay, but it is extremely doubtful. At present the deposits are worked entirely by native men, women, and children, who sell the gold to the concessionaire at a fixed price per gramme. There are some very narrow and patchy quartz leaders traversing Archean rocks, and a few rich pockets have been found, but generally speaking they have as a whole proved disappointing.

Considerable sums have been spent in prospecting for coal and petroleum, but so far without any profitable result. While it is not safe to prophesy that no workable deposits will be found, investors should be exceedingly wary of the alluring proposals of promoters.

Several outcrops of lead, zinc, and silver ores have been found, but none have proved sufficiently valuable or so favourably placed as to be worth working at present. As regards copper, transport difficulties and lack of fuel have prevented the development of some interesting discoveries in the interior. A deposit near the coast has recently been reported from whence it is hoped it may be possible to ship ore.

No workable deposits of tin or platinum have yet been reported. Oxides of uranium, thorium, cerium, and other rare earths are fairly abundant in the volcanic region of Antsirabe, and quantities were exported before the war to the Continent. There are some deposits of mica and asbestos well worth being looked into, but transport is likely to prove a drawback. Corundum crystals for abrasives are abundant and large quantities have already been exported. Semi-precious stones, such as aqua-marine, beryl, sapphire, zircon, topaz, tourmaline, spessartite, rubellite, and garnet, of good size and quality are fairly abundant and figure for an important sum in the exports.

Owing to the irregular character of their distribution their exploitation is left to individual native prospectors. Diamonds have not yet been reported. Graphite is by far the most interesting mineral found in Madagascar, and under suitable conditions will prove the most profitable to work.

THE EXTRACTION OF RADIUM

By JOHN S. MacARTHUR.

EVERYONE has heard of radium, and everyone knows more or less of its wonderful property of atomic suicide, which proceeds so rapidly that the energy evolved by the succession of atomic catastrophes manifests itself to the senses as light and heat, and yet so slowly that the action lasting over centuries with only slight diminution is not unfairly called permanent.

Its power to form new elements from its own ruins, to induce chemical change, especially metabolic change, and to produce light are well known. Generally its properties are recognized, and are being further elucidated by hundreds of investigators, men and women, highly skilled in research. With all this study of radium itself, there is little common knowledge of its sources and how it is extracted. This paper may add to the common knowledge on this almost neglected side.

It was observed long ago that radium was always found in association with uranium in ores. It has more recently been proved that radium owes its existence to the infinitesimally slow disintegration of the uranium atom. Thus a large mass of uranium disintegrates very slowly, and in doing so produces some radium, which disintegrates more quickly. The process of exceedingly slow formation on the one side and comparatively rapid disintegration on the other, results—after a period measured in millions of years—in a state of equilibrium in which the ratio of uranium to radium is about 3,250,000 : 1. As these elements are unfamiliar in elemental form the ratio is generally expressed in terms of uranium oxide, U_3O_8, to hydrated radium bromide, $RaBr_2 2H_2O$, as 1,750,000 : 1. This means that if we could get an ore consisting of uranium oxide without gangue one ton would contain radium equal to 571 milligrammes of radium bromide. Such an ore does not exist. The nearest approach to it is pitchblende, the basis of which is uranium oxide, but it is always associated with other metal oxides notably of lead and bismuth and the rare earths. Even pitchblende is not mined for its own sake. It is found fortuitously in primitive rocks associated with tinstone, wolframite, and other ores. In bygone years the pitchblende thus obtained was laid aside and sold as occasion offered for its uranium content. After the discovery of radium, the old heaps were picked over and over again, so that there is little pitchblende to be had now in old dumps. Hitherto no deposit of pitchblende has been developed into a mine, and the demand for radium must be otherwise satisfied.

Autunite is a double phosphate of uranium and lime, which occurs distributed over a wide area in the granite rocks of the northeast of Portugal. As taken from the vein, the ore seldom contains more than 1% or 1·5% of U_3O_8. Concentration by mechanical means has not been found practicable, and thus the ore is generally treated by chemical means as it comes. A considerable portion of the world's radium is derived from this ore.

Carnotite is a complex ore consisting essentially of vanadium existing as oxide, or with potassium as double silicate, and associated or loosely combined with uranium oxide. It occurs chiefly in the Rocky Mountains over a wide area extending about 100 miles on each side of the northern Colorado-Utah boundary.

The ore occurs in pockets in a sandstone or shale country. It seems to have resulted from aqueous impregnation following the lines of horizontal stratification. The country abounds in fossils of recent date, and this has suggested that the carnotite is too 'young' to permit of the radium having attained its full equilibrium value. The mathematical computation for this period based on data still far from complete is about 10,000,000 years, a period comparable with most calculations of, or guesses at, the age of the earth whether based on astronomical, physical, or biological data. In point of fact the uranium-radium ratio is little different in carnotite from other ores of unimpeachable antiquity, and one need not look for such differences, seeing that by all other methods of computation the earth itself is not old enough to comply with the demands of radio-active mathematics. The interesting subject is dealt with fully in Joly's 'Radioactivity and Geology.' We must admit, however, that our data are imperfect, and it may be that a better foundation for calculations will be obtained from work undertaken by Soddy to determine by direct experiment the rate at which uranium produces and accumulates radium.

Variations in the uranium-radium ratio have frequently been observed in different minerals, but it was not possible to deduce any rule from such observations; and recent work has shown that in many cases, if not all, the discrepancies disappeared when large quantities were taken, and that the variations were due to minutely local and slight enrichment or impoverishment. This is not surprising, seeing that uranium and radium are quite dissimilar elements, amenable to different solvents and different precipitants; for instance, sodium bicarbonate dissolves uranium but not radium, and sulphuric acid precipitates radium but not uranium.

The treatment of complex ores is necessarily complex, and radium ores are no exception to this rule, and there is no standard method of treatment. If there were, it would be too involved to interest the ordinary reader, but one or two important leading principles may be laid down.

As radium is analogous to, and by all purely chemical tests indistinguishable from barium, it suffices to treat an ore as if one wanted to extract barium, which, generally speaking, is converted to carbonate by treatment with carbonate of soda, the carbonates thus formed being dissolved in hydrochloric acid and separated from most of the soluble constituents by precipitation with sulphuric acid. This precipitate contains, besides the radium, the barium and lead contained in the ore. If barium is not contained in the ore, a small portion of a barium compound must be added. The other constituents of the ore, such as uranium, vanadium, and bismuth, are dealt with by ordinary laboratory methods applied on the industrial scale.

Finally, one has to deal with a mixture of barium and radium sulphates, the former in overwhelming excess, say one part of radium to 100,000 of barium. The mixture of sulphates is solubilized by carbonating as before, dissolved in hydrochloric acid and crystallized. It is found that when such a solution is saturated at the boiling point and allowed to cool, it deposits half of its barium, which contains four-fifths of the radium. This fractionation is repeated time after time, passing the crystals forward and the mother liquors back, so that each lot of back-going mother liquor meets the lower lot of forward-going crystals to form a new solution for a fresh crop. The net result of a long series of such fractionations is that we get at the upper end a small fraction of say 100 milligrammes of almost pure radium chloride, and at the other end a very large fraction of crystals of barren barium chloride, with a large and valuable stock of intermediate products between the two extremes.

The figures involved in the radium industry baffle the imagination. As an ordinary carnotite ore assaying about 2·5% U_3O_8 contains radium equal to only about 12·5 milligrammes per ton, we cannot expect to extract more than a maximum of 10 mgms. from such ore, which is one part out of a hundred million. The human mind cannot grasp this figure; it cannot even grasp one million. We all understand a day or an hour as a unit; one million days would take us back to the times of Nineveh and Babylon, one hundred million hours would take us back more than 11,000 years, and to extract 10 mgms. from a ton is like selecting 10 minutes out of the Christian era.

In view of these figures, it is impossible that radium can ever be cheap. The cost of mining in remote, almost inaccessible, mountains and of transport to centres of industry forms a high initial charge, and the fact that each constituent of the ore, not excepting silica, has to be dealt with chemically, involves high charges for chemical solvents and precipitants. Then the long, tedious fractionation at the end means a serious lock-up of capital. All the operations require labour of the greatest intelligence, and scientific supervision of a high order.

Fortunately the physical properties of radium make it possible to detect and determine with speed and accuracy the amount present in low grade material, say from 1 to 1000 mgm. per ton. In the higher grades the excessive energy of radium makes its determination more tedious if not more uncertain, just as we can do quicker and closer work with a thermometer than with a pyrometer.

If radium is not likely to be cheap, can it be plentiful? This common question must be answered in the negative. Apart from its other and more subtle power, radium generates heat enough to raise one hundred times its own weight of water from the ice melting point to boiling point *per hour*. If radium existed in any quantity much greater than now, the heat would accumulate to such an extent that the earth would be uninhabitable. Some of the best qualified authorities state that even now the small—one is tempted to say negligible—amount of radium in the earth is accumulating heat and may be the cause of recent seismic disturbances. The subject is fascinating, but much too extensive for an article in *The Mining Magazine*.

GLASS SURFACES IN CONCENTRATION

By W. H. TREWARTHA-JAMES.

What the glass surface is, how it is made, and how it works. It is extremely sensitive, possibly beyond the limits of workability. Glass surfaces are admirable for laboratory test work and a standardized set should be in all laboratories.

WHILE a new method is in course of evolution, only those who have had personal experience of the difficulties and obstacles which have to be overcome can fully appreciate why conflicting results may be obtained in the first trials under working conditions. In the absence of a simple description of the process by the patentee, one is necessarily reduced to the consideration of the descriptions as found in the patent specifications, which being couched in technico-legal terms, often tend to conceal the critical factors more than to reveal them. The general public cannot always form an intelligent idea of the new operations claimed to have been discovered, or how they are accomplished. Having seen a few trial tests on glass surfaces in actual operation in Cornwall, I venture to comply with your suggestion to give an elementary description of the system so far as I can. My purpose is certainly not destructive criticism, but rather if possible to interest the technical world so as to get constructive suggestions from those who have specialized on concentration work.

Mr. Morley Martin claims to have discovered that better results can be obtained in the water concentration of 'ores,' and more particularly 'slimes' by the employment of glass surfaces in various forms of plant now in use. These surfaces have the additional advantage that suitable standardized fluted and frosted surfaces are already manufactured for lighting purposes, and can be commercially procured in a sufficient and suitable range for the fineness and conditions of the mineral pulp to be treated. No doubt as experience is gained, special types of glass sheet may have to be manufactured for particular purposes. Frosted surfaces can be graded as required by treating the glass with sand of a definite size by the sand-blast machine. The frosted surface may also be pitted as well if desired. The fluted surfaces are also frosted by sand-blasting, and may be of the type known as 'Hartley's roll.' They may be graded both as regards the depth and shape of the flutes and the distance between them. The range of available glass surfaces is capable of almost indefinite variation. In the absence of photomicrographs a few freehand sketches (cross-sections) of various forms of glass, as observed under a powerful lens, approximately magnified about three times, but not drawn to scale, may give some idea of types of surfaces.

In this particular set of figures the forms are all on glass $\frac{3}{8}$ in. thick, and contain 16 flutes per linear inch, with the depth of riffle of $\frac{1}{16}$ in., except No. 6 which is $\frac{1}{32}$ in. deep. I understand the exact shape of the wells and of the crests, whether round or angular, can be produced, varied, or controlled by the degree of heat at which the glass is rolled. The frosting of the riffles and crests cannot of course be shown without greater magnification.

The pulp stream containing the crushed mineral which it is desired to concentrate, for instance cassiterite, arsenical pyrite, iron and copper pyrite, wolfram, galena, etc., is allowed to flow over suitable selected glass surfaces, or a series of different glass surfaces, fixed at a suitable inclination, the stream flowing at right angles to, that is across the riffled surfaces. The selection of suitable surfaces is based partly upon microscopic measurement of the particles, and upon sizing or grading the particles by elutriation, confirmed by actual tentative tests of standard gradings on a fixed inclined surface.

The primary result of the frosting, pitting, and fluting of these glass surfaces appears to be to produce proportionate retardation of that part of the pulp stream with which the glass surfaces are in contact. The heavier mineral particles fall down from the retarded stream and settle in the wells of the riffles or flutes in a formal manner, their ultimate recovery being dependent on the action of the pulp-feed stream and of the wash water which follows. So far as is known, these glass surfaces have been mainly adapted to two forms of plant: (*a*) The normal Cornish 18 ft. round revolving frame; (*b*) the Cornish fixed inclined frame.

The Cornish revolving round frame, having an even and controllable distribution of pulp, considerable capacity, continuous action, easy adjustment of water washing, and facility for discharging the concentrate, appears admirably suited for the adaptation of these glass surfaces. But the fitting of the sheets in plane radial sections on the curved surfaces with rubber or cement joints presents some mechanical difficulties in the formation of grooves or valleys, which have so far only been partly overcome by stepping the joints, or by producing proper curved sheets which at first are necessarily more expensive to procure; later on no doubt this difficulty will be overcome.

In the Cornish round frame there are two methods of removing the concentrate from the riffles of the glass surfaces. In one, a brush crosses the riffles with a mechanical reciprocating movement and jets of water, lift, convey, and discharge the concentrate into the troughs connecting with the hutches. In the other a rotary brush acts along the lines of the riffles, instead of at right angles thereto, and accomplishes the same object.

The Cornish fixed inclined rectangular frame appears admirably suited for the adaptation of these glass surfaces; the cheap commercial sheets suit the plane surface, the period of washing can be controlled, and the inclination of the tables can be varied or adjusted. Moreover, the table can also be tilted sideways at right angles to the flow of the stream to facilitate the complete discharge of the concentrate by jets of water operating on the riffles, which movement the patentee has included in one of his specifications.

From my own observations I conclude that these glass surfaces are exceedingly sensitive to variations in the mechanical and physical conditions of the pulp, and this appears to be the practical point which has yet to be translated into full-scale work before a decisive demonstration or test can be given. Hence the following factors appear to require careful consideration and adaptation:

(1) The selection of a suitable glass surface (or a suitable series of glass surfaces) adapted to deal with a more or less uniform type of pulp, which must not vary between certain limitations as to sizes of particles, pulp dilution, and the relative percentage of mineral contained.

(2) The adaptation of the slope of the surface with special regard to the degree of dilution of the pulp, that is, the proportion of dry pulp to water, and the other conditions above mentioned.

The flat inclined frame, discharging the concentrate by tilting sideways, appears ideally adaptable for making quick concentration tests, and should I think now be placed in every concentrating laboratory. Standardized sizes and types of glass sheets can easily be placed on, or removed from, such a table, and that is the simplest way of studying and testing quantitatively the value of these surfaces.

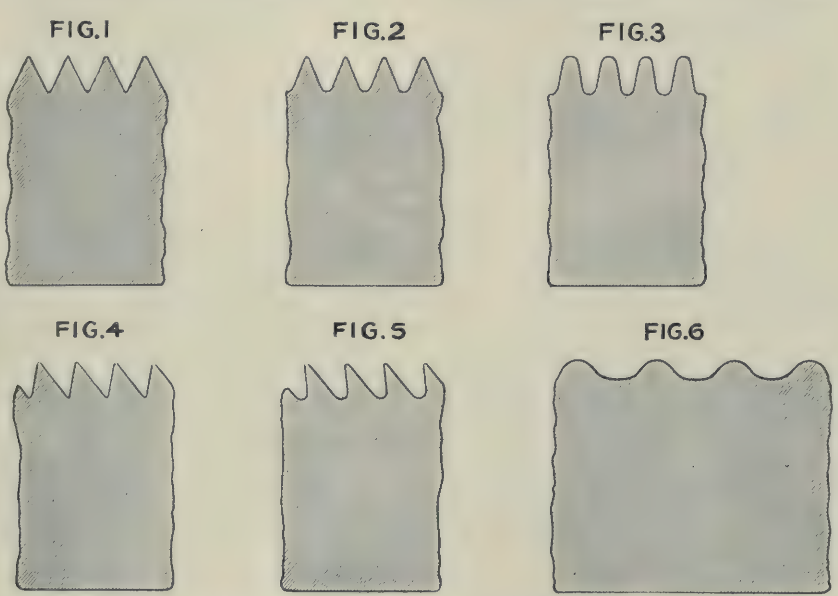


Fig. 1. Sharp angular crests and wells. Fig. 2. Angular crests and rounded wells. Fig. 3. Rounded crests and wells. Fig. 4. Steeper slope up-stream; angular crests and wells. Fig. 5. Steeper slope up-stream; rounded crests and wells. Fig. 6. Rounded crests; shallow wells.

DISCUSSION

Glass-Top Concentrating Tables.

The Editor:

Sir—I read with interest the editorial on glass surfaces in concentration in the January Magazine, and the results of comparative tests conducted by Messrs. Bewick, Moreing & Co. at East Pool, under the personal supervision of their extremely able manager, Mr. M. T. Taylor, to whom my sincere thanks are due. Will you kindly afford me an opportunity of commenting upon phases of both the test and the process itself that may allow of conclusions being drawn from a somewhat different point of view.

It is erroneous to suppose that this process is merely the substitution of the present concentrating surfaces of wood, rubber, linoleum, and other materials by glass, and it is impossible that data obtained by years of labour can be explained in relation to a single test of one class of pulp in a mine. Speaking generally, the aim has been the re-stating of the gravitation system of concentration with greater precision, commencing with a structureless surface, glass, whereon are built up retardation values of extreme precision without any interference of surface natural to any other basis.

Heresy though it may be, the results obtainable incline one to think that the function of specific gravity as generally understood in ore dressing can be considered in a slightly different way and that surface retardation is, in reality, not a minor factor but the most important of all. Such retardation when properly applied appears to be proportional to the varying specific gravities of the component constituents of the solid particles in any given pulp. In other words, when scientifically applied, the difference in the rate of travel between varying specific gravities is attained with consequent separation. Obstruction of surface is not retardation; the former obstructs the whole, the latter retarding in a given order.

To say that in dressing operations unless a particle of mineral touches the surface over which it is being concentrated it cannot in the nature of things be recovered by the gravitation method is, of course, a platitude, but none the less true, and, therefore, in so far as order and precision of the factors necessary for its retention there are present in that surface, it surely follows that better results should ensue. Order is ever superior to chaos. Two particles of the same mineral, the one one-thousandth and the other a ten-thousandth of a milligramme may be of precisely the same specific gravity, but their total weights are in the ratio of 1 to 10. These particles passing over an inclined plane of such 'chance' surfaces as wood, rubber, and linoleum, and subjected to the same moving power of water are obviously not under identical conditions. The one may be retained in virtue of its total weight, the other washed away as a result of the power of water being greater, not than the specific gravity could stand, but greater than its total weight could sustain. But if a surface refuge from this deleterious energy of the running water (which is necessary to dressing operations) can be formed in the concentrating surface itself in such a manner as to ensure retardation as distinguished from obstruction within such refuge, and thereby lower both mineral particles into a plane out of the action of this deleterious force, and in such a manner as to accommodate both, they will both be recovered.

A perfect surface, would, I think, result in a perfect recovery. To illustrate this action, possibly the following data may be of interest. The weights and assays of the products are those of an independent assayer to whom the material was handed as it came from the surfaces.

Pulp assaying about 12 lb. of tin per ton was in this case fed on to an ordinary wood surfaced revolving round table. At the point where the feed commenced, a 12 in. square of one of my standardized glass surfaces was placed upon the bed of the table in such a manner that the feed from the distributor passed over it. This was allowed to revolve with the table until it passed through all the feed area into the cleansing water area and until it reached a point immediately in front of the scrubber when it was carefully removed and the contents of its surface washed by means of a wash bottle through a funnel into a suitable bottle. Following this glass surface consecutively were seven other different glass surfaces each 12 in. square, all differing in

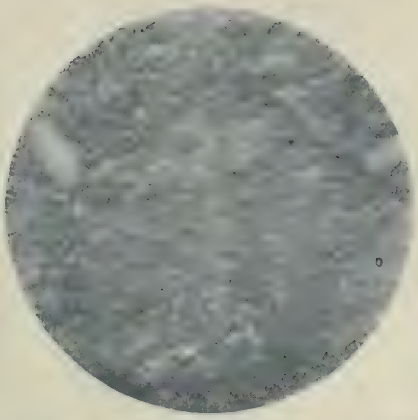


Fig. 1. Photomicrograph of linoleum surface of a well-known table, magnified 15 diameters. A 'chance surface.'

Fig. 3. Photomicrograph of wood surface of Cornish revolving round table magnified 15 diameters. Superior to that shown in Fig. 2 in precision of retardation value for fine slime, but still a 'chance' surface.

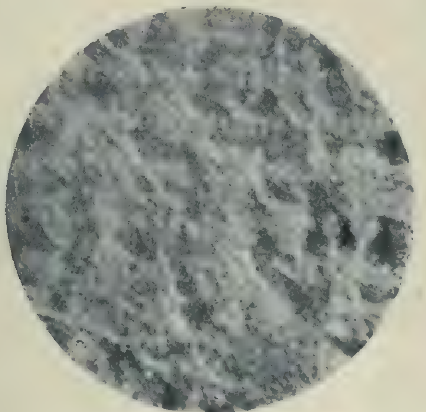


Fig. 2. Photomicrograph of rubber surface of a well-known table, magnified 15 diameters. Superior to the surface shown in Fig. 1, but still a 'chance' surface with obvious limitations of retardation value.

Fig. 4. Photomicrograph of standardized glass, selected from a possible hundred or more of different retardation value. A surface of precision and order suitable for slime mineral particles varying from one-threethousandth millimetre to one-tenthousandth millimetre.

PHOTOMICROGRAPHS OF SURFACES OF VARIOUS MATERIALS USED ON CONCENTRATING TABLES.

their surface standardization and retardation value, and the contents of each were transferred in a similar manner to a separate bottle. The respective contents of these on weighing and assaying gave the following results:

	Units	Sn lb. per ton
No. 1.	113·00	28·50
,, 2.	49·50	24·15
,, 3.	14·15	85·99
,, 4.	1·34	364·64
,, 5.	2·97	255·56
,, 6.	3·00	169·57
,, 7.	70·70	11·11
,, 8.	49·50	9·66

These surfaces it will be noted were fed with the same pulp, over the same time, with the same cleansing water, in fact they were subjected to identical conditions of treatment, and yet they yielded products varying in assay from 9·66 to 364·64 lb. of tin per ton, and in their units of weight of total solids from 1·34 to 113.

In a word, according to surface condition, so are the results, and two or possibly three different surfaces on the same table may be necessary. Surely then if surface is paramount, to get such surface under control so as to obtain what is desired must be advantageous and superior to a chance surface with unalterable capacity and grade of product producible therefrom. The one can be made to do what you want it to do, and the other can not.

To take a glass surface and to dump it

down upon a more or less obsolete machine without the necessary structural alterations, and to say that I am going to try glass against wood, without paying due regard to the nature of the pulp and the work which the surface has to perform, is scarcely a procedure, which will result in showing what suitable surfacing will do. Moreover, what a standardized surface will do upon a revolving round table ought not to be confused with what the glass surfaces themselves are capable of under perfect conditions.

Relative to the East Pool test, there are mechanical defects, some easy of remedy in that table; and, as a matter of fact, the glass surfacing was placed there for the treatment of a totally different class of material from that which was fed on to it for the test, the figures and results of which you have published. Moreover, the report admits that owing to structural defects the ratio of the bulk of the pulp in half the area of the defective joints compared with twice such area off the glass itself was one to four and the assays as 7·5 to 5, therefore the 6·5 tailing of glass is obviously not the correct tailing of such glass surface when these defects are remedied. The mistake made in laying this table was that a continuous valley was tried as an experiment, and found defective. I now lay the segments so that the upper ones are so arranged that the slight valleys discharge on to the centre of the lower segments, thus obviating this difficulty, and have practically shown at the Tincroft mine that by a curve in segments *all* valleys are obviated. But taking that test as it stands, may I ask a question? The pulp fed on to the table contained tin oxide, copper sulphide, arsenical pyrite, and wolfram, all of economic value to the mine. Why then are the results confined to tin alone? Where are the figures for the copper, arsenic, and wolfram?

It is stated in the report that the concentrates from the glass contained a greater proportion of the arsenic and copper sulphides than the wood did, presumably ascertained by weighing. Ought not the figures, therefore, to have been embodied in the report of the results? The point is important, as, in not publishing those results are you not possibly and unintentionally withholding the key to the whole position?

If a pulp assayed 0·5% of copper existing in the form of copper sulphide assaying 10% copper metal when separated from all other accompanying minerals and gangue, it must of necessity follow that the original pulp contain 5% of such copper sulphide, and if the concentrate from the glass assayed, say, 6% copper metal it follows that 60% of that concentrate would then be made up of copper sulphide. Add to this an equal concentration of the original arsenical pyrite and wolfram contents, it is obvious that it would not be possible to obtain any very high percentage of tin in the first concentration of such a mixture, whereas on the wood surface, which admittedly did not retain so much of these minerals, there was a greater opportunity (owing to their absence) of a higher grade tin product being obtained, whereas it was not of half the tin assay value. That is to say, a concentrate of high valuable sulphide content assaying 37 lb. of tin per ton could scarcely be compared from the point of view of value with a concentrate from the wood not half the tin assay value and no corresponding sulphide content. One could apply the term 'extraction' to the former, but could you reasonably apply it to what is simply a slightly concentrated pulp with accompanying losses of valuable sulphide content of pulp, even in a concentration of tin content from 9·2 to but 15 lb. per ton?

If the mines will install this system of surfacing, which is in a much more advanced stage of development than is generally supposed, paying due regard to the work it has to perform, and use the one, two, or three surfaces on the same table, I have no doubt the results will be of great economic value, because very extensive tests have shown that the respective effluents from our local mines (material which they at present throw away) in almost every case when passed over my suitable standardized glass surfaces produce a product richer in assay material value than the ore being sent to battery from the respective mines producing those effluents, and as this can be done for pence per ton, against the well known cost of production of the ore, the inference is obvious.

The old spirit "I am shure we caant catch any moore, we'll do as our faathers befoore," if it ever existed is not present with us today, but on the other hand I am convinced that a much closer attention to technical advice, combined with a willingness to allow of essential structural alterations in certain types of tables prior to surfacing, will go far to help in the recovery of the greater portion of the £300,000 to £400,000 of mineral in this county estimated as now being lost yearly.

W. MORLEY MARTIN.

Redruth, January 24.

Glass Surfaces on Concentrating Tables.

The Editor:

Sir—I read the figures resulting from the East Pool test with great interest, and I congratulate the Magazine on being the first to publish figures on this interesting subject, the value of which is greatly increased by the editorial interpretation of the results. The technical world must thank Messrs. Bewick, Moreing & Co. for placing these figures at their disposal. I think we are all agreed that these figures do not give a final answer to the question everyone is asking as to the value of these surfaces, and I think they will encourage our concentration experts to look thoroughly into this interesting development.

I happened to visit East Pool works while the tables were being adjusted, and can confirm what you say about the care taken by Mr. Taylor in making arrangements to ensure reliable records. From a concentrating point of view the assays of the other heavy minerals present, wolfram, mispickel, and chalcopyrite, in the various products is of importance, and I hope it may still be practicable to have these mineral contents determined in all the products, or at least in the concentrates, as I believe further valuable information would be obtained in this way.

I have the complete analyses of a similar set of samples taken from another works, in which a somewhat similar comparative test was being made, but I am sorry the figures are not available for publication. None the less, these figures confirm the statement that the concentrate from the glass table was richer in all the minerals, and strikingly so in regard to arsenical pyrite, on which the samples showed a remarkably high extraction. I need hardly say that in Cornwall a valuable by-product in the form of crude arsenic is recovered from concentrate of this character in the roasting process. Moreover in this test the two concentrates (from the wood and from the glass tables) were much closer together both as to value contained and as to ratio of concentration.

Dealing now with the results as far as they can be based on the tin content of the products, it is obviously difficult, if not impossible, to compare a concentrate containing 32·2 lb. metallic tin per ton and a concentration ratio of 10 tons of feed into one ton of concentrate from the glass surface, with a 15 lb. concentrate and a ratio of 3·6 into 1, unless both samples are corrected for what I may call the 'tin-yard factor,' that is the net cost, including loss in cleaning the concentrate and bringing it up to a saleable percentage, say 65 to 70% metallic tin. Moreover, the chemical assay only returns the total metallic tin content, so that no comparison can be made between two products on the basis of the amount of free cassiterite present in the samples. Probably the two concentrates did not contain the same amount of tin oxide in the form of granular aggregates of quartz-cassiterite particles, which had not been crushed fine enough to free the cassiterite. The proportion of this product in the higher grade concentrate may have been much smaller. Some light would have been thrown on this matter if both types of concentrate had been carefully vanned without re-grinding, and an approximate estimate thus formed of the quantity of free cassiterite that might be expected to be obtained from both products. The cassiterite so obtained should also be chemically assayed to determine the percentage of metallic tin content.

If it were only desired to compare two products, of two different tables, in their intermediate form, two other tests appear to be required: one with the wood table adjusted to produce as nearly as practicable a 32 lb. concentrate, the glass table working as in the test; in the other the glass table would be adjusted to produce a 15 lb. tin concentrate, the wood table remaining as adjusted during the test. Even then, as you point out, these tests would only serve to indicate the result of working the tables against each other, under these set conditions. They might give valuable information, but they would not serve to indicate the results that would be obtained when both tables are adjusted independently to the conditions for which each is best suited.

From my few short observations, I conclude that these glass surfaces are exceedingly sensitive to variations of conditions in the constitution of the pulp treated, and success appears to me to depend upon the adaptation of the working conditions to suit them. The points may be thus summarized:

(1) The particular shape and character of the glass surface (or it may be necessary to use a series of different glass surfaces) must be closely adapted to the character of the pulp to be treated, particularly having regard to the range of the sizes of the particles, the degree of dilution of the pulp, and the percentage of heavy mineral contained.

(2) The inclination or slope of the glass surfaces may require very close adjustment to suit the conditions mentioned above.

I should be sorry to see at this early stage any destructive criticism submitted on the basis of the preliminary trials. The difficulties inherent in working out suggestions of this character are well known, and are appreciated by those who have had experience in developing new methods. If anyone can offer constructive suggestions I feel sure they should receive consideration. The necessity for improvements in the recovery of the "Elusive Pimpernel"—cassiterite—from its ores in Cornwall was never greater than it is today, and any man who can show how recovery can be improved must be considered a public benefactor.

W. H. TREWARTHA-JAMES.

London, January 29.

[We regret that limitations of space prevent us publishing this month additional letters or our comment upon the suggestions of our correspondents. We shall recur to the subject.—EDITOR.]

Mineralization in Malaya.

The Editor:

Sir—In your October issue my name is mentioned several times in an article by Mr. W. R. Jones, who was in this country for three years as my assistant. Mr. Jones even thinks it incumbent on him to assure your readers that I did not put forward a certain theory in order to create a sensation, and I shall be glad if you will grant me some of your space to mention certain points in connection with his contribution.

Mr. Jones' paper on the origin of the tin ore deposits of the Kinta district is the subject of correspondence between me and the officers of the Geological Society. Anyone who reads my views on the subject will recognize that they are unbiassed. I have said they require corroboration, and last year I stated in the *Geological Magazine* that if anyone would propose a better explanation I would accept it. The appearance of Mr. Jones' paper and his remarks in your columns have surprised me, because toward the close of 1914, in consequence of certain information that reached me, I invited Mr. Jones to add anything he liked to a statement of arguments for and against the glacial theory and another theory originally put forward by myself and discarded as untenable, which is, as far as I can see now, in the main the theory put forward by Mr. Jones. Mr. Jones said he was unable to comply unless I gave him three weeks for field work in Kinta, which I had to refuse on account of other work. Minutes in this Department show that for the rest of his term of office Mr. Jones was working at high pressure to finish work in Selangor. Mr. Jones could not discuss the origin of the Kinta tin ore with me, on his own showing he had no time to prepare the paper, which he did not mention to me before he left, yet in August, 1915, he wrote to me a letter, a copy of which is now with the Government, in which he informed me that he had read the paper before the Geological Society, and that he had made the same subject the main thesis for a Doctorate of Science. This letter left no doubt as to the spirit in which Mr. Jones' paper had been prepared.

Mr. Jones also mentions certain tin deposits on Gunong Bakau. I gave Mr. Jones an opportunity in 1913 to prepare a report on these for the Chief Secretary. The following is an extract from that report: "Bibby's lode: The tin ore is obtained from the undecomposed rock, and it is interesting to note that there are distinct differences in its character in different parts of the mine. These differences illustrate in a striking and conclusive manner the well-known theory of 'differentiation of granite,' and it will be helpful for the economic development of the mine to bear in mind that the differences in the rock are more apparent than real, that what seems to be a totally different rock is only *a modification of its neighbour*. The whole of Ulu Bakau and the neighbourhood is formed of granite and its modifications, pegmatites, aplites, quartz veins, and *topazized granite or greisen*." (The italics are mine. J.B.S.).

It is clear from the above that Mr. Jones had no idea of the topaz-bearing rock being intrusive, but that he thought it a modification of the surrounding granite.

I had occasion to work out the structure of Gunong Bakau thoroughly later and found, contrary to my own expectations, that the topaz-bearing rocks are intrusive. In January 1915 I gave Mr. Jones a copy of the paper that he quotes. In a memoir on Ulu and Kuala Selangor that Mr. Jones has left behind him he says nothing about the origin of these topaz-bearing rocks, but I see that in the contribution to *The Mining Magazine* he does. On page 199 he says they "appear to be intrusive," and if anyone compares what Mr. Jones says with my paper he will see that Mr. Jones' explanation differs from mine only in one point, namely, that he says the topaz was formed from felspar, whereas I believe it was formed from groups of molecules that would have solidified as felspar if they had not been disturbed by hydrofluoric acid. Mr. Jones, after writing the above extract, adopts my views as to the rock being intrusive, and then writes of "Mr. Scrivenor's present revolutionary theory." Perhaps Mr. Jones will explain some time why he did not tell me of the views he holds now before he left my department, and why he wrote on page 17 of his 'Clays of Economic Importance in the Federated Malay States,' "Mr. J. B. Scrivenor has recently described a case where topaz was an original mineral. See article 'The Topaz-bearing Rocks of Gunong Bakau.' *Q.J.G.S.*, April 1914."

There are certain passages in the article that call for further comment. At the bottom of the first column of page 198 a passage occurs that is familiar to me. Mr. Jones cited Messrs. Thomas and MacAlister in support of a suggestion, which is not new, that tin in certain cases may have come from below as a sulphide, etc., and not fluoride. If you will turn to the named pages (86 and 92) of Messrs. Thomas and MacAlister's book, you will find that on pages 86, 87, 92, and 93 is certain well-known matter militating *against* the point on which Mr. Jones proposes to write a short paper. I pointed out to Mr. Jones long ago that this reference was not apropos.

On page 199, column 1, Mr. Jones writes: "Mr. Scrivenor considers that the topaz and cassiterite in the two rocks, which he names 'quartz-topaz' and 'topaz-aplite,' are not alteration products of previously formed minerals, but crystallized from the molten rock as topaz and cassiterite, and he has written a very interesting paper on the subject. Previously, however, he had described the quartz-topaz rock as valueless."

Mr. Jones refers to my Ulu Pahang publication (1911), page 24. What I then described as of no value was a rock found under the beacon on the summit of Gunong Bakau. It was composed of quartz and topaz, and I called it valueless because I knew no one would buy either mineral. In 1914, however, I finished my work in connection with the rocks of Gunong Bakau, which had commenced in 1904 (Mr. Jones came here in 1912), and as I found quartz and topaz to be the only constant minerals, I called the rock that yields the tin ore, the 'quartz-topaz rock.' Mr. Jones conveys the impression that I have called tin-bearing rocks valueless, which is a mistake evident to anyone who will read the page referred to.

Mr. Jones goes on to say: "Mr. Scrivenor was unaware, etc., etc." This is not the case, as Mr. Jones could have discovered for himself by reading the page he quotes.

I am unable to find anything in Mr. Jones' 'Clays of Economic Importance in the Federated Malay States,' justifying his statement on page 201 of *The Mining Magazine* that the significance of the freshness of felspar in the Chendai-Menglembu granite in relation to the theory of kaolinization by the agency of hydrofluoric acid has been described by him. He quotes my description of the rocks on page 18 of his paper.

Finally, on page 200, Mr. Jones gives reasons why he thinks certain mining engineers who have examined Gunong Bakau are wrong in considering some of the veins horizontal and parallel to one another, and on page 199, Fig. 4 has the legend ". . . one of the supposed horizontal lodes. . . ." The reason why some of these orebodies are believed to be more or less horizontal by the mining engineers mentioned and myself, is that they have been followed into the hillside by means of drifts. On Mr. Bibby's land a vein has been followed in for about 300 ft., almost horizontally. It then rises slightly.

J. B. SCRIVENOR.

Batu Gajah, December 9, 1915.

[It should be remembered that the second and concluding part of Mr. Jones' contribution was not yet available to Mr. Scrivenor when he wrote as above, but in justice to his views it seems proper to publish his letter without waiting for any additions or modifications that he may wish later to make. The importance of the problem of genesis of Malayan lode tin is sufficient to warrant giving full space to the discussion. We may mention that reprints have been prepared of Mr. Jones' articles and that in them are corrected a few minor errors that crept into the original text.—EDITOR.]

Losses in Tin Recovery.

The Editor:

Sir—I read with much interest a summary of the paper recently read by Mr. W. H. Trewartha-James before the Royal Polytechnic Society of Cornwall. A few years ago I made some trials on tin ore from the Waterberg district of the Transvaal, and the results I obtained were much better than those of the mines working in that district. I endeavoured without success to get some of the parties interested in the mines to make further trials, but they seemed to consider that the use of stamps weighing 2000 lb. to crush the large crystals of cassiterite found in the Waterberg district was the last word in tin recovery.

My trials were conducted on the following lines. I heated the mineral to a dull red heat and plunged it direct from the heating apparatus into water. The effect was to render the mineral extremely friable, in fact so much so, that the pressure of the hand was sufficient to crush two pieces in the same way as one crushes two walnuts in the hand. I crushed the friable mineral in a pair of light rolls. Speaking from memory, I made a recovery in one instance of 86%. Unfortunately when I was away on commando, some of my papers were mislaid, the notes relating to these trials being among them. I should mention that some of the mineral on which I experimented was tough, and I consider that heating and sudden cooling will make even the toughest rock friable. And it must be remembered also the crystals of cassiterite found in the Waterberg district, with the exception of some found in the eastern portion, are much coarser than the cassiterite of the Cornish mines.

The judgment I formed from the result of the trials is that the sudden contraction of the heated ore caused by plunging it into water detaches the crystals of cassiterite from the gangue owing to probable unequal expansion of the particles of various contained minerals. In other words it is possible by artificial means to do in a few hours what nature does in long periods of time, namely, to detach the crystals of cassiterite from the surrounding gangue. To detach the cassiterite from the gangue with as little sliming as possible should be the goal in tin-dressing, and a method of treatment on the lines I have indicated appears to me to be leading in the right direction.

I think that the subsequent crushing of the friable mineral should be done by light rolls and not by heavy stamps. As regards the cost of rendering the ore friable, this should not exceed sixpence per ton if done in a suitable heating furnace, that is, a heater having an automatic feed and discharge. The cost of sixpence per ton is based on coal at 14s. per ton at the mine. The charge of 6d. per ton or even up to 9d. would be covered by the saving effected in the cost of the subsequent crushing. The extra recovery of cassiterite would be all to the good.

This ancient method of rendering ore friable is also applicable to gold ores, and the subsequent crushing could be done by comparatively light rolls instead of heavy stamps. This would mean a very much smaller capital expenditure.

It is a simple matter to make trials of tin ores on the lines I have indicated, and I hope some of our Cornish friends will do so.

G. H. Blenkinsop.

Johannesburg, October 11.

Electric versus Steam-Driven Dredges.

The Editor:

Sir — In your editorial on 'Progress in Dredge Design' in *The Mining Magazine* of August last, you bring up an interesting subject. In comparing steam and electric power for dredging, it is to be remembered that small steam units scattered over the dredge never could operate with the same efficiency as the one turbine engine. One of the difficulties, both in building and operating the dredge, is the number of steam pipes that must be put in and kept in order. The vibration of the boat, and the rough jars it must sustain, make leaks hard to avoid, and this is especially unfortunate in the matter of exhaust pipes. It is almost impossible to maintain a high vacuum and consequent high efficiency with a number of these pipes running from individual engines to the condenser. Another matter is the decrease in efficiency of running due to the care that must be taken in starting each engine, draining the cylinders, looking after lubrication, packing, etc., whereas the individual motors require little attention and are always ready to start or reverse at a turn of a handle. In the case of the Mambuloa dredge, it would have required a 500 hp. boiler if direct steam drive had been employed in place of the 300 actually used. Even where another dredge is not contemplated, therefore, the central power plant has its advantages. Continuous service is important, and it is no uncommon thing for a steam turbine to run 24 hours per day for months.

Relative to cleaning buckets, I may add that much may be done by correct designing. The Mambuloa bucket presents an absolutely smooth interior with no rivets or shoulders for clay to lodge against. It has also an even taper throughout its depth, so that it makes free and easy dumping even in clay. In operation no jets of water to clean it have been found necessary.

It is attention to points such as these, adapting each dredge to its particular work, as you mention, that makes for successful and economical operations. I can assure you that dredge builders are quite as anxious as consulting engineers for that harmonious interchange of information that you urge.

A. C. Ludlum.

New York, December 16.

SPECIAL CORRESPONDENCE

CAMBORNE.

MINERS AND MILITARY SERVICE.—Just now the mine officials are busy claiming exemption from immediate military service for the unmarried miners who have enlisted under the Derby scheme. Tin mining has been scheduled by the Board of Trade as one of those industries which it is desirable should be kept going as of cardinal importance for the maintenance of some other branches of trade and industry, and as a consequence it is possible, by an appeal to the local tribunal, for the mine authorities to get their underground employees put back into the latest group. It is obvious, if present outputs are to be maintained, that the already depleted supply of miners should not be further reduced. Indeed in many cases, particularly in the outlying mines, losses are being made, simply because the lack of underground labour has necessitated a reduction in the output out of all proportion to the heavy standing charges. Seeing that tin mining is regarded as an industry which it is important, from a national standpoint, should be carried on, it is difficult to understand why certain of the surface employees should not also be exempt; for it is not sufficient only to secure an adequate output from below. Obviously, certain skilled employees engaged in the reduction and dressing operations are equally indispensable, and their omission from the exempted list is an illustration of the lack of practical knowledge shown by government departments. If there had been a Chamber of Mines in existence that could have claimed to represent the Cornish mining industry, no doubt this and other matters would have been energetically represented to the Government with probably satisfactory results; as the writer knows from experience, no one company can present its case with sufficient force to move a government department, though representations from the industry as a whole would be certain to command attention.

LEVANT.—This famous old mine, the only one of any size now using the cost-book principle, continues to be worked at a loss, the adverse balance for the sixteen weeks ended December 18 last being £527. During this period, 8647 tons of ore was milled, and 132 tons of black tin was sold, showing a recovery of 34 lb. per ton. In addition copper and arsenic to the value of £1349 were recovered. With black tin averaging £87. 5s. per ton, and ore being treated with a recovery of 34 lb. per ton, the average outsider would assume that something must be wrong for the old 'bal' not to pay its way. But it must be remembered that the mine is situated many miles from a railway, and that all stores have to be hauled by traction over a wretched road, that the mine workings, being under the sea where ventilation is difficult are abominably hot, and labour efficiency consequently rather low; and finally, that the lodes are small and expensive to work.

The question of the new lease is still unsettled. The lords have agreed to a further extension of the old lease to July 1917, which should give ample time for the negotiations. The adventurers are pressing for a lease under which, in the absence of profits, there will be no royalties payable. It is interesting to record that during the past twenty years the net profit earned amounted to £67,077, out of which the royalties on the mineral produced were no less than £32,370, or approximately 48 per cent.

EAST POOL & AGAR.—The value of the discovery, reported over a year ago, at the 240-fathom level north of East Pool shaft, work on which was suspended for many months owing to water difficulties, has recently been materially enhanced by the intersection of the same lode at the 212-fm. level. The lode, where intersected, showed excellent values, and is of as great width as in the lower level. A rise has connected the two levels, and was in good ore all the way. The policy of the management is thoroughly to develop this new orebody before making plans for stoping on a large scale, so that this discovery will not be materially reflected in the returns for many months to come.

WHEAL KITTY & PENHALLS.—The report of this company for the six months ended December 31 last illustrates clearly the many difficulties under which the tin mining industry is labouring owing to the war. The lack of labour, a 30% increase in the price of coal, and the higher cost of other materials, together with a £7 fall in the price realized for the company's tin concentrate, much more than account for the small loss made of £492. We fear that small mines of this character with limited cash resources, and which of necessity are forced to follow a hand-to-mouth policy as regards development, will, owing to the war, have a very hard struggle to keep their flags flying. Mr. J. H. Collins, who manages this company, and who deserves so well of Cornish mining, will, we hope, be favoured with a stroke of luck in the near future. The St. Agnes district, in which this mine is situated, is noted for its 'bunches,' and we trust that one will soon turn the luck at Wheal Kitty. The erection of the new Californian mill makes slow progress, owing to the difficulty in getting mechanics. The main developments are in the bottom of the Sara's section of the mines, but owing to lack of funds, these have had to be suspended, and work is to be confined to the upper levels.

TRIBUTERS.—At a recent meeting of the Levant shareholders there was a breeze caused by Capt. W. James, manager of the Basset mines and a member of the committee of Levant, stating that as one who had been a tributer himself he had never found in Basset or Levant five per cent of them to be honest men. This strong assertion not unnaturally drew from the mine officials a defence not in the tenderest of language. Tributers have been taboo at Basset for many years past, and perhaps this policy is justified in a mine of such a character, but Levant, with its narrow rich lodes, is essentially a tributer's mine, and they ought to be encouraged. The miners of today are not the skilled and keen tributers their fathers were; there are still a few men left who are prepared to take a pitch of a speculative character, but in a general way they prefer tutwork to tribute. Many important discoveries have been made by tributers in the past, and where suitable conditions exist they should be encouraged.

JOHANNESBURG.

TRANSVAAL MINING DIVIDENDS.—There was not much change in the total amount of dividends declared during 1915, as compared with 1914, the apparent decline being attributable to the bonuses distributed in 1914. The most gratifying features were in connection with the companies operating in the Far East Rand, Brakpan, Geduld, Van Ryn Deep, and all the various Modderfonteins declaring increased dividends. Other companies which have not yet attained their full development, like the City Deep, Knight's Deep, and Consolidated Langlaagte, also did better. Several mines approaching exhaustion naturally distributed smaller amounts among their shareholders. The Village Main Reef, for instance, only distributed 20% as compared with 70% for the previous year. This fall was due to some extent to earth tremors, but also to the so-called selective method of mining adopted in previous years.

The greatest disappointment of the year was provided by the decreased dividends paid by the huge amalgamated companies, particularly the Crown Mines, where the distribution fell from 85 to 65%, which, it may be mentioned, was only half what was anticipated at the time of the amalgamation. This is all the more disappointing, on account of the huge capital expenditure incurred in order to place the property on a sound dividend-earning basis, and also because the amalgamation was expected to make the operations quite independent of fluctuations of grade. It will be seen that the variations in the ore-content were more serious than it was possible to counteract, despite the far-seeing policy pursued by the administration. It is more than a coincidence that at the East Rand Proprietary Mines a similar fall in dividends has occurred, and it cannot be considered cheerful to find Randfondtein Central only being capable of paying 2½% dividend in two years. It is well to draw attention again to the increasing tonnage of ore milled required to produce the same amount of gold. On the nominal capitals of the producing companies, the dividends declared during the year averaged 32%.

The coal companies did on the whole much better last year. All except one declared a dividend, the total paid to the shareholders reaching £339,238, as compared with £276,848 for the previous year. This shows an increase of average dividends on the nominal capitals for the year of from 10 to 13%, and it is the highest average dividend paid by the coal companies of the Transvaal.

COAL PROSPECTS IN THE KARROO.—For nearly forty years the residents of Cape Town have been buoyed with the hope that sooner or later a huge coalfield of economic value will be found in the Karroo. It may be that the Ecca shales by their appearance lend themselves to this view, but the first to support this idea was the late Dr. Dunn, one of the earliest of the Cape geologists. Since his time the subject has been revived many times, principally by Cape geologists who happened to possess little knowledge of South African coalfields. Their advice has led to the expenditure of much money in boring and prospecting, but the results have always ended in disappointment. The latest venture in the attempt to prove the existence of a coalfield in the Karroo district of the Cape province is the Karroo Syndicate, recently floated in Cape Town, to prospect a property of over 100,000 acres, situated in the Laingsburg district, about thirty miles northwest of Prince Albert Road station, on the main line of railway from Cape Town to Kimberley and Johannesburg. The property is situated on the Ecca beds, which throughout South Africa are always found to occur below the productive coal measures. It is true that Dr. Corstorphine maintains that the coal measures of the Transvaal and Natal are contemporaneous with the Ecca beds, but no other geologist of repute holds that view. Consequently it naturally follows that there is little hope of finding workable seams of coal in the Ecca formation, and some surprise is expressed that, after the disappointments experienced both in the Cape province and Natal, any one should be induced to find capital for such a hopeless venture.

In the property under notice, however, there occur vertical fissures filled with coal of a semi-anthracitic character, but its origin and how it was deposited in the fissures has not up to the present time been established. There are two distinct fissures, running parallel and about five miles apart, already traced for a distance of about twenty miles. On one of the fissures prospecting shafts have been sunk along the strike for a distance of 3000 ft. These prospecting shafts give a section of 9 ft. of debris, followed by 20 ft. of weathered coal, which in turn rests on compact coal with small fragments of shale with rounded edges. The coal is described as being a second rate semi-anthracitic coal, similar in character to the coal seams found in the Cape coal measures of the Stormberg beds, but much cleaner in character. The analyses of the coal vary considerably, fixed carbon running from 74 to 90%, volatile matter from 4 to 14%, and ash from 2 to 17%. The calorific value varies from 12 to 15 by the Mahler bomb. Within a radius of 100 miles there are various similar occurrences of coal in vertical fissures, some containing coal with less than 1% of ash, and a calorific value of 16.

Nearly forty years ago, when little was known about the geology of the South African coalfields, Dr. Dunn suggested that workable coal seams might be found at the base of the Ecca beds, a theory which he considered was supported by the position of the coal seams at Vereeniging. Dr. Corstorphine arrived at the same conclusion after an inspection of the Vereeniging coalfield some time ago. As a result of this expression of opinion, considerable sums of money have been wasted in prospecting for coal in the Ecca beds both in the Cape province and Natal, and it would seem that the Karroo Coal Syndicate is about to repeat the operation. On the erroneous assumption that the South African coalfields are of Ecca age, the engineer in charge of the prospecting operations for the Karroo Syndicate has commenced boring operations under the impression that the coal filling the vertical fissures has been forced up from coal seams at the base of the Ecca beds. No convincing evidence in support of this theory has been advanced, and seeing that the occurrence of workable seams of coal in the Ecca beds is opposed to the views entertained by most geologists, it is difficult to see how the boring operations can be crowned with success. It is of course possible that thin erratic seams of coal may be found in the Ecca beds, but nowhere in South Africa have workable seams of coal been yet discovered in the Ecca formation.

A more probable explanation of the occurrence of coal in the vertical fissures would be that it has been carried there by water, rather than that it has been forced up from below. The fact that some of the fissures contain coal carrying less than 1% of ash strongly supports the theory of the aqueous origin of the coal, and the fact that in some places rounded particles of shale are found mixed with the coal in the fissures likewise supports this view. At all events not only are the geological aspects against the probability of workable seams being found in the Ecca beds, but the results of prospecting, both in the Cape and Natal, show that these beds always occur below the productive coal measures.

THE NEW RAND.—Another long report has been issued by Mr. A. R. Sawyer, the consulting engineer of the New Rand, Ltd., regarding the results and prospects of the last two bore-holes sunk in search of the Main Reef Series north of Heilbron in the Orange Free State. For several years the company has been engaged on this task, no less than 21 bore-holes having been put down in the hope of striking the Main Reef Series and thus discovering a new Rand. According to Mr. Sawyer each of the last half-dozen bore-holes ought to have struck the Main Reef Series, but each bore-hole has in turn resulted in disappointment, due to dikes, intrusions, or faults. Despite Mr. Sawyer's well sustained optimism in the task he has undertaken, these results ought by now to convince him that the solution of the problem is not as easy as he considers. It would take too much space to again describe in detail the large amount of work done by the New Rand, Ltd., in the effort to discover a new goldfield forming a southerly continuation of the Rand. It must be admitted that if the Rand does extend beyond its present known boundaries, the area selected by Mr. Sawyer was one of the most likely for prospecting operations. So far the Orange Free State is the only part of South Africa offering sufficient attraction for prospectors in this direction, but everywhere the results have been disappointing, and it seems as though Mr. Sawyer may eventually have to share the fate of his predecessors. Judging, however, by the last report of Mr. Sawyer, the last two bore-holes ought theoretically to be on the track of the elusive Main Reef Series, but broken ground was encountered just where No. 20 bore-hole ought to have struck the reef horizon, and a diabase intrusion intervened when bore-hole No. 21 was about to reach the same horizon. The bore is to be continued down to such a depth, through the diabase intrusion, to strike the reef horizon, which in the opinion of Mr. Sawyer only lies a few hundred feet below the depth of 2511 ft. at which the bore-hole was stopped. Once again, therefore, the operations of the New Rand, Ltd., are entering upon an interesting phase, and it is to be sincerely hoped that at last, if the Main Reef Series is not struck, some definite information will be obtained showing the true horizon in the Rand formation that the bore-holes have reached.

MELBOURNE.

THE SULPHIDE CORPORATION has profited by the high prices for lead, and by the veto on exportation of lead-silver ores. Its works at Cockle Creek, near Newcastle, New South Wales, have taken all the ores from the smaller mines outside of Broken Hill. Thus the ores from Zeehan, Tasmania, that used to go to the Tasmanian Smelting works or to Germany, are now taken to Cockle Creek, and also most of the gold concentrates from the various small mines scattered over the Commonwealth. The returning charges have been recently raised, partly no doubt on account of higher wages and cost of materials, freights, etc., but chiefly because the works provide the only outlet for silver-lead ores, copper-lead ores, and gold concentrates, outside of the Port Pirie works. There is also an extensive superphosphate plant at Cockle Creek which turns out excellent grades of manures suitable for wheat and sugar growing. These superphosphate works are the most northerly in the Commonwealth, the others belonging to Mount Lyell, and Wallaroo & Moonta, being farther south and west along the coast. The Cockle Creek manures have an outlet all over New South Wales and Queensland. The profits made from the lead bullion and manures have been more than enough to off-set the loss of revenue due to the inability to sell all the zinc concentrate. Of the latter some 4500 tons is made monthly, and only a fraction is exported to Seaton Carew in England. Before long the export of lead bullion may be expected to cease, as a lead refinery is about to be built.

THE PROHIBITION of export of 'unfinished' metals is already having an effect on local smelters, situated at sea board. It means making additions and enlargements to present plant. Thus the Electrolytic Company at Port Kembla will have to spend £50,000 during 1916 in enlarging its capacity, and it is not to be expected that this company will charge as low a toll for blister copper as was obtained in England and the United States, for, up to the present, the company has not paid any dividends. The only person that has benefited has been the pre-war selling agent, Aron Hirsch und Sohn, who must have made close on £9000 a year for about 10 years. Since the beginning of the war the copper is only refined at Port Kembla, and each mine has to sell its own copper. The Wallaroo will have to enlarge its works in order to take the blister copper from Cloncurry and mattes and ores hitherto exported. The Port Pirie works are still being enlarged, and the Fremantle works are reported to be about to reopen. The latter have existed precariously for 15 years. Formerly they used to buy lead concentrate from Broken Hill and smelt the gold concentrate from Kalgoorlie. Not having any mine the works languished, until the Northampton lead mines near Geraldton were opened. Now it looks as if a fair supply of lead ores will be obtained from this district, enabling the company to begin a customs trade. The 3000 to 4000 tons of tin concentrate that was formerly exported to Singapore will now have to find smelting accommodation at Mount Bischoff, Sydney, or at other works to be built.

The effect of the veto against the export of unfinished metals is 'protection,' that is, it gives the privilege of keeping local smelting works in full swing, but producers must necessarily pay more for smelting their ores, and, as the metals must be sold on London or New York prices, plus heavy freights, a continuance of high metal prices will be required to make it worth producing the ores. Just now, there is of course an excellent outlet for both copper and lead in the East, and to Vladivostok. During 1916 shipments of electrolytic copper may be expected to average 600 tons monthly to the latter port.

CLONCURRY, in North Queensland, while it is not yet all 'one company' as is the dream of some, tends to become three main groups of producers: the Hampden, with its Duchess, Trekelano, and several other mines; the Elliott, with Dobbyn, Hampden Consols, and other smaller mines; and the Cuthbert group, north of Cloncurry. Outside of these, but likely to be merged into the Elliott group are the Mount Oxide and Mount Gordon. The smaller mines are virtually under mortgage to these more powerful groups, for once their richer oxidized ores are depleted, they are forced to sell their lower-grade ores to the nearest smelter.

THE METAL EXCHANGE at Melbourne is quietly settling down to work, and is so far chiefly a registry office. The Sydney Exchange has not even got so far. It is still necessary to compile rules to cover sale of ores, mattes, concentrates, and various coppers, as well as the standardization of buying and selling contracts to be settled. As, in the end, London Metal Exchange rules must govern all sales, it would appear simpler to adopt these as far as possible right from the start. Australian trade with the Germans is of course dead today, and naturally every effort is being made to prevent a post-war revival of it. However, Australia cannot exist without imports and exports, and everything cannot go to or come from England. Japan is profiting largely by the cessation of German imports. In pre-war times, four ships were in the Australian-Japanese trade, now it takes fifteen or more to carry the goods to and fro. It looks as if we had demolished one bogey only to erect another.

Shortly after this reaches England, London will be visited by the Prime Minister of the Commonwealth, Mr. W. M. Hughes. This gentleman is one of the most vital spirits in the dependencies of the Empire. As Attorney-General of Australia he made it his duty to initiate a crusade against all things that are German, and especially against the hold that the traders of that people had on the metal industry of Australia. Like Mr. Lloyd George, Mr. Hughes is a Welshman. He is short of stature, sturdy, slightly deaf, a splendid speaker, and quick and apt at retort. Moreover he is alert to business considerations, possessed of an exact knowledge of the authority resting in him, and with such force of character as to compel most people opposed to him to swallow the leek whether they care to do that gracefully or with distaste. Mr. Hughes's visit will certainly be used to push forward his favourite idea, the treatment of the zinc concentrate of Australia under the flag. Though a free-trader, it is certain that he is firm as a rock on the questions of making Australia a self-contained nation, and of preference to Britain and her Allies if need be. Here one of his feats certainly has been the creation of the Metal Exchange. It is not stretching the truth to say that his action in compelling all transactions in metals and concentrate to go through that body was most distasteful to a certain body of men with large interests in mining. Fortunately one or two of them soon saw that a new factor in public business life existed in the Attorney-General. They used their influence to induce their associates to realize the position also. They have now done that, the result being that the Metal Exchange is a working institution. Had the opposition developed, it is not difficult to imagine that the leader of the Labour Party, with its socialist proclivities, would have used the powers he possesses under war legislation to have instituted state control over the base-metal industry of the country. Certainly, if Mr. Hughes had felt that the interests of the nation demanded such a course, he possessed the pluck and determination to give effect to his ideas. Moreover the rank and file of his party would have applauded his action to the echo. As far as Australia goes, the most important development since the war is the pro-British ideal in the metal trade, and the forcing of that trade by the Attorney-General into channels approved by the Imperial authorities but sanctioned by him personally.

TORONTO.

PORCUPINE.—It is reported that as a result of the steady increase in production at Porcupine, there is a revival of interest on the part of British investors. Some investigations have recently been made on behalf of a prominent British mining firm, resulting, it is stated, in an offer to purchase a controlling interest in the Hollinger and other properties owned by the Canadian Mining & Finance Co. While this is mere rumour, there is a prevalent idea that before long British capital will seek investment here, where conditions are now very different from those obtaining a few years ago. The future of the district is now assured, and the exorbitant terms at which undeveloped prospects were held in the early days have given place to more reasonable expectations on the part of claim owners. The production of the Dome Mines for December stands higher than that of any preceding month both as regards the tonnage treated and the value of the output, which was $160,950. The production for 1915 was $1,468,272 from 317,873 tons of the assay-value of $4·56 per ton, as compared with an output of $1,058,629 from 219,609 tons of the value of $4·99 per ton in 1914. It is expected that with the installation of the Hardinge ball and pebble mills and the increase in the cyanide capacity, the tonnage will early in the spring be increased to over 40,000 tons monthly. The McIntyre during the quarter ended December 31 milled 26,160 tons of ore for a yield of $184,233, a recovery of 95·42%, at an operating cost of $4·16 per ton with a profit of $75,485. An addition to the mill, which should be completed in February, will bring the total milling capacity up to 450 tons per day. A large orebody 19 ft. in width and averaging $18 per ton has been discovered by diamond drilling at a vertical depth of 750 ft. The Dome Extension, which has been closed down for three years, is being re-opened with Captain Anchor as manager. Active exploration will be undertaken, and an endeavour will be made to find by diamond drilling some of the veins that come in from the Dome at depth. The Porcupine Premier Mining Co., recently organized with a capital of $1,000,000, has bought the Standard adjoining the Dome Lake and will sink the shaft to 500 ft. The Schumacher mill is crushing about 100 tons of ore per day. Ore is being stoped on the 300 and 400-ft. levels and the vein is being followed at the 600-ft. level.

The Triumph Mining Co., which has taken over the Success mine at Porcupine, has cut a shear zone in cross-cutting on the 100-ft. level.

COBALT.—Much interest attaches to the sinking of the Beaver shaft to a depth of 1700 ft., at which point the lower Keewatin formation will be reached, as the result will determine the depth of the orebodies in that section of the district. Good progress is being made, a station having been cut at the 1300-ft. level and sinking resumed at the rate of about 100 ft. per month. The Timiskaming will also sink their shaft, which is now down 900 ft., to the lower Keewatin. The latter company has cut an extension of its rich vein on the 500-ft. level, farther to the south, extending the oreshoot an additional 75 ft. At the Nipissing a winze sunk on vein 490 below the 4th level of the Meyer system, disclosed a rich ore-shoot 8 in. wide carrying 7000 oz. to the ton. It left the winze a short way down, owing to a fault which has apparently lowered the formation about 100 ft. The winze is being continued down, and an endeavour will be made to recover the vein by cross-cutting at depth. La Rose Consolidated, the ore reserves of which were supposed to be nearly depleted, appears to have a chance for a new lease of life. At the beginning of 1915, the ore reserves were estimated at 859,119 oz., but the actual output of the year amounted to 1,154,000 oz., the profits being about $220,000. Recent important discoveries on the Chambers-Ferland, which is developing three high-grade veins on the 400-ft. level, have encouraged the La Rose to undertake exploration by diamond drilling near the Chambers-Ferland boundary, which may materially increase its ore reserves. The Agaunico mine, which has been taken over by the Coniagas, is being unwatered preparatory to an examination of the workings with a view to active development. The Adanac, which has been endeavouring to tap a rich vein coming in from the Timiskaming, has struck an ore-shoot in a winze below the 200 ft. level, rich in silver.

NICKEL REFINING IN CANADA.—It is announced that negotiations between the Canadian Government and the International Nickel Co., which now exports the matte from its Sudbury mines to be refined in New Jersey, have resulted in an arrangement under which the company will establish a refinery on the Canadian seaboard, probably in Cape Breton, to be operated under government supervision. It is understood that only a few minor details remain to be settled before a final conclusion is reached.

OTHER DISTRICTS.—A shaft will be sunk 150 ft. on the King Dodds claim, Kowkash, and drifts run on the 50-ft. and 100-ft. levels. At the Miller Independence, Boston Creek, a new vein, striking directly across the vein first discovered, has been found, carrying free gold and sulphides. A shaft is being put down on the original discovery.

PERSONAL

PIERCE BARKER has been appointed chief chemist to the Anaconda Copper Mining Company.

EDGAR BONDS sailed for West Africa on January 26, on his way to the mine of the Taquah Mining & Exploration Co., Ltd.

LESLIE BRADFORD, a member of the Broken Hill Proprietary's staff, and known for his work on roasting and flotation, is now at the company's iron and steel works at Newcastle.

F. LESLIE BROWN, of the Consolidated Gold Fields staff, holds the rank of major in the Mechanical Transport section in the East African Expeditionary Force.

WALTER LYMAN BROWN is with the Commission for Relief in Belgium, 3 London Wall Buildings, London, E.C.

R. H. P. BULLEN has returned to the Mysore mine, India, after a visit to England.

A. D. CARMICHAEL, formerly of Broken Hill, and an inventor of the Carmichael-Bradford desulphurizing process, has died in New York.

THOMAS P. CARR has returned to Rio Tinto.

FREDERICK CRATHORNE, lieutenant in the 252nd Tunnelling Company, was killed in France on January 14. He was a native of Vryheid, Natal, studied at Camborne Mining School, and did good work in Angola, on the Gold Coast, and in Nigeria.

H. B. CRONSHAW has been appointed professor of geology of mining and mineralogy in University College, Galway.

GORDON S. DUNCAN, who was recently operated upon for appendicitis, is convalescent.

J. F. B. ERDLETS, Jr., who has been in Holland for the Commission for Relief in Belgium the last half year, sailed for New York on the *Tuscania*. He will make his headquarters in the United States hereafter.

J. R. FINLAY has been elected president, and WALDEMAR LINDGREN vice-president, of the Mining and Metallurgical Society of America.

C. M. FISHER passed through London on his way to Paris late in January.

W. GULLOCK has been appointed manager of the Nuggety Ajax mine, Daylesford, Victoria.

CLAUDE V. HAINES is leaving shortly for Santa Ana, Colombia.

E. H. HAMILTON has been appointed consulting metallurgist to the Consolidated Mining & Smelting Co. of Canada, at Trail, British Columbia.

J. T. HARDMAN has been appointed manager of the White Crystal tin mine, Ardlethan, New South Wales.

C. R. VAN HISE has been elected president of the American Association for the Advancement of Science.

AUSTIN F. HOY has returned to London after a visit to the United States.

PIERRE HUMBERT, who has been in Brussels for the Commission for Relief in Belgium, is now in London.

STANLEY HUNTER has received a commission as captain in the Australian Miners' Corps.

R. HOWARD JOHNSON has left London for Naraguta, Northern Nigeria.

A. R. KARPINSKY, of Petrograd, has been awarded the Wollaston medal of the Geological Society.

J. F. KEMP has been awarded the medal of the Mining and Metallurgical Society of America for distinguished work in economic geology.

E. S. KING was in London from Cornwall recently.

H. W. LAWS is home on leave. He was staff officer for mining in the Dardanelles, and holds the rank of major. He was awarded the D.S.O. in November.

G. F. LAYCOCK has returned from Atbasar.

T. M. LOWRY, major in the Royal Engineers, lectured recently before the Cornish Institute of Engineers on the work of the mining companies in Northern France.

YASUKUMA MATSUBAYSHI has been visiting British collieries.

WILLET G. MILLER has gone to Cuba in connection with the work of the Ontario Nickel Commission.

WILLIAM NEILL was a recent visitor in London from Glasgow.

F. FREETHY OATS is major in the 134th (Cornwall) Heavy Brigade Royal Garrison Artillery and is with the East African Expeditionary Force.

C. R. PINDER is consulting engineer to the Mexico Mines of El Oro.

H. POMEROY has received a commission in the 3rd Cheshires.

ROBERT M. RAYMOND has been appointed professor of mining in the Columbia University.

GEORGE A. RICE, chief mining engineer for the United States Bureau of Mines, has removed from Pittsburgh to Washington.

W. H. RIGG was one of the victims in the sinking of the *Persia*. He was on his way to Burma.

E. J. RODDA is manager of the Mouramba copper mine in New South Wales.

W. J. ROSE, a member of the staff of the Amalgamated Zinc (De Bavay's) company, has received a commission as captain in the Australian Miners' Corps now in process of formation.

W. H. RUST has resigned as manager of the Tacoma smelter.

H. SHARPLEY sailed on the *Kenilworth Castle* on his return to South Africa to take control of the management of the Pigg's Peak mine.

W. E. SIMPSON has left for Canada. He will make Haileybury his headquarters for the present.

SYDNEY A. R. SKERTCHLY has sailed for South America on his way to Puno, Peru.

E. A. CAPPELEN SMITH has been elected a director of the Chile Exploration and the Chile Copper companies.

M. T. TAYLOR attended the January meeting of the Institution of Mining and Metallurgy.

B. B. THAYER, president of the Anaconda Copper Mining Co., has gone to Chile.

J. B. TYRRELL is expected here from Canada.

D'ARCY WEATHERBE has gone to America for a short trip.

HAROLD WHITTINGHAM, formerly manager of the Gennamari mine, Sardinia, has been promoted to captain in the Royal Garrison Artillery, and is on active service with the 71st Heavy Battery.

H. A. J. WILKENS and W. B. DEVEREUX, Jr., have formed a partnership as consulting engineers and mine managers, with offices at 120 Broadway, New York. O. F. Westlund will represent them in Mexico City and Gordon S. Duncan in London.

A. H. WILLIAMS has returned from Nigeria and has gone to South America.

H. M. WOLFLIN, recently in charge of mine inspection work in California, has been transferred to the Pittsburgh station of the United States Bureau of Mines. EDWIN HIGGINS, who has had charge of the work in the Lake Superior and Missouri regions, has been given the Californian appointment.

H. C. WOOLMER is chairman of the British War Refugee Relief Committee at Moscow, not the British War Relief Fund.

LOUIS A. WRIGHT has joined the staff of the American Metal Co., and has gone to Chile, where he expects to remain for two years.

METAL MARKETS

COPPER.—A check to the upward movement manifested itself early in January. Prices opened around £86, and were carried up to £91, when they collapsed, and rapidly fell to £84. The decline was assisted by a circular from the Ministry of Munitions to the consuming trades requesting them to refrain from purchases of refined copper in quantities over 50 tons at a price over £100 without reference to the authorities. The effect of the circular seems to have been misunderstood, for the official selling price is in fact a fluctuating one according to the market, and efforts to obtain supplies from the authorities are beset with so many restrictions that users find it more convenient to buy from dealers. A fresh upward movement soon manifested itself, and after some fluctuations, £91 was again realized, and prices once more settled down about that level. The open account in standard copper has been shown to be small, and prices are easily swayed upward and downward. Electrolytic copper does not share in these movements, but grows from strength to strength. This is due to the independence of producers, who are well sold, and to the difficulty of securing freight. The American price has risen from 23 cents to 25¾ cents, and in England from £107 to £130. Naturally consumers are reluctant to pay these advanced prices, and business is confined to comparatively small parcels. Russian demand, however, keeps steady, and a good inquiry continues to be felt from there. American advices point to firmness, and to a large production being completely absorbed by increasing consumption, with a premium for spot metal. The position in England still looks strong, and higher prices are inevitable. The statistical position is becoming still stronger.

Average prices of cash standard copper: January 1916, £88. 2s. 11d.; December 1915, £80. 17s. 10d.; January 1915, £60. 17s. 7d.

The price of sulphate of copper is quoted in chemical merchants' circulars at £45 per ton, but we doubt whether purchases at so low a price can be made at present. Copper tubes were quoted on February 7 at 16½d. per lb., copper wire at 14¾d., tough copper £114 per ton, best selected £115, rods £134, sheets £134. Brass sheets 15½d. per lb., wire 15d., solid drawn tubes 15½d., brazed tubes 17½d.

TIN.—Prices have tended upward, with a rise of over £10 for the month of January; £180 was reached at one time, but the close is somewhat lower than this. In America spot metal is scarce, and £212 has been realized. There is considerable difficulty in obtaining permits, and direct shipments have been hindered by the interruption in steamship services. This applies equally to shipments for France and Italy. There is a heavy demand for Vladivostok, which is being supplied direct from the Straits and Java. Business from the latter, however, is hampered by the unfavourable exchange. The home position is not altogether satisfactory, consumption being restricted owing to the difficulty of obtaining supplies of steel and acid. Straits shipments were smaller than estimated, and sales were made at full prices. The outlook is for still higher levels, with fluctuations.

Average prices of cash standard tin: January 1916, £175. 16s. 4d.; December 1915, £167. 3s. 10d.; January 1915, £156. 14s. 6d.

LEAD.—The continued advance in prices has been giving considerable anxiety to the munitions authorities. In response to their expression of disfavour at the high level of prices, efforts are being made to stem the advance, and dealers have loyally met their wishes by realizing holdings. The root of the matter, however, is the lack of shipping opportunities from Spain, where large parcels are held up at the shipping ports. This difficulty is being met by Government action in freeing transports for bringing home supplies, and meanwhile the control of the market is being obtained by sales on Government account. Foreign supplies have been small, and American sales in this market have been insufficient to affect prices, the demand in the United States being too heavy to permit of any considerable export. Spanish production has been largely finding its way to France, Italy, and Russia for munitions, and what is left for our market is much under normal. Australia has also been sending us much less than in ordinary times. The American price has advanced from 5·50 cents to 6·10 cents. In England from £29. 15s. to £32 was realized, but the market is now rather lower, and it is very desirable that the efforts being made to keep prices at a more reasonable level shall be successful. English refiners are still handicapped by the unsatisfactory labour conditions.

Average prices of soft foreign pig lead: January 1916, £30. 17s. 5d.; December 1915, £28. 8s. 8d.; January 1915, £18. 12s.

SPELTER.—The official price has risen from £88—£78 to £91—£83. Early material is difficult to get, and the freight difficulty which is mainly responsible for the advance is very acute. America is not a seller before March, and sales are reported as far forward as July. American production for 1915 is cabled as 453,585 tons, an advance of 42% on 1914. Ores are being shipped to the United States from the Mediterranean as well as from Australia. The galvanizing trade in this country is in a deplorable condition.

Average prices of good ordinary brands: January 1916, £83. 12s. 5d.; December 1915, £82. 4s. 1d.; January 1915, £30. 16s. 1d.

ANTIMONY.—The market for this metal continues in the same restricted condition, and prices are purely nominal. The last published quotation was £120 per ton. Even Chinese crude is without a figure. Antimony ore is quoted at 9s. per unit. In America supplies of antimonial lead have increased, so that the market for the metal itself has been eased.

QUICKSILVER.—The price of Spanish quicksilver has been steady during the last six weeks or so at £16. 10s. per flask of 75 lb. In America a great shortage exists and fluctuations in price have been wide, as much as £40 to £50 per flask having been paid. The imports of quicksilver into Great Britain during 1915 are reported at 40,579 flasks as compared with 37,568 flasks in 1914.

BISMUTH.—10s. per lb.

COBALT.—8s. per lb.

CADMIUM.—7s. 6d. per lb.

PLATINUM.—As the Government has taken this metal in hand, the metal cannot now be bought. Johnson, Matthey & Co., as agents for the Government, are prepared to buy at 200s. per oz. In America the quotation is from £15 to £18 per oz., but new buyers have difficulty in securing supplies. In another part of this issue, we give details of metals and alloys suitable as substitutes for platinum for dental purposes.

ALUMINIUM.—Dealings in this metal are only allowable under Government permit, and the quotation is nominal, though £160 per ton may be mentioned. Besides being used in motor car and aeroplane construction the metal is being required in powdered form as a constituent of the explosive ammonal used in hand grenades. In America the demand does not appear to be so great, and prices have eased to £125.

NICKEL.—The quotation remains at £225 per ton. Elsewhere in this issue we give details of the negotiations in Canada in connection with the refining locally of all or part of the Sudbury production.

CHROMIUM.—Quotations of chrome ores are as follows: New Caledonia 53 to 55%, basis price for 50% Cr_2O_3, £6. 10s. per ton, scale 2s. 6d. per ton. Rhodesia 48 to 52%, basis price for 48% Cr_2O_3, £6. 5s. per ton, scale 2s. Rhodesia 47%, £6 per ton flat. Baluchistan 53 to 55%, basis price for 50% Cr_2O_3, £6. 10s. per ton, scale 2s. 6d. Ferro-chrome 8 to 10% carbon, £32. 10s. per ton, basis 60% chromium, scale 10s. per unit; 6 to 8%, £33. 15s., same basis; 2% carbon, £86, same basis.

MOLYBDENUM.—The price of molybdenite remains unchanged at 100s. per unit averaging 90% MoS_2. Supplies are promised from Eastern Ontario in the spring, and also from Tasmania. Ferro-molybdenum 18s. per lb. of metal contained.

TUNGSTEN.—The statutory price of wolfram and scheelite remains at 55s. per unit of WO_3. Tungsten steel for high-speed tools is now being sold at 2s. 10d. per lb. for 14% tungsten and 3s. 10d. for 18% tungsten. Ferro-tungsten 5s. 8d. per lb. Tungsten metal powder 5s. 10d. per lb. The Geological Survey reports that during 1915 the output in the United States of wolfram and scheelite concentrates averaging 60% WO_3 was 2165 short tons, as compared with 1821 tons during 1910, the previous best year.

TITANIUM —Ferro-titanium 15 to 18% Ti, and 5 to 8% carbon, 6½d. per lb.; 23 to 25% Ti free of carbon, 1s. 9d. per lb.

VANADIUM.—Ferro-vanadium, 14s. 6d. per lb. of vanadium contained.

FERRO-SILICON.—Basis 75% Si, £48 per ton, scale 10s. per unit; 45 to 50% Si, basis 45%, £28. 10s., scale 7s. 6d. per unit.

MANGANESE.—The quotation for Indian ore, 50%, is 2s. 8d. per unit, and for Brazilian ore 50%, 4s. per unit. Before the war the prices were 8d. to 10d. per unit. Ferro-manganese £20 per ton. Metallic manganese, free of carbon, 2s. 8d. per lb.

IRON.—Last month we mentioned that the Government had taken steps to regulate the prices of iron and steel and that maximum prices were being fixed. The producers of pig iron are still in doubt as to the interpretation of the Government's intentions, and quotations in most cases continue to advance. No. 3 Middlesbrough pig iron is quoted at 88s. 6d., a rise of 10s. during the month, and comparing with 51s. 6d. before the war. Bessemer pig iron is lower at 127s. per ton, but is still just double what it was before the war. Spanish hematite ore has further risen to 40s. per ton as compared with 38s. a month ago, and 17s. 6d. before the war. Swedish iron ore 36s. per ton nominal. The quotations for structural steel are: Steel rails £11; ship plates £11. 10s. at Middlesbrough, £12. 10s. at Glasgow: boiler plates £13. 10s. at Glasgow; angle irons £11. 2s. 6d. at Middlesbrough, £13. 15s. at Glasgow.

SILVER.—The silver market during the past month has been devoid of interest, and the price has moved up and down between 26¾ and 27¼d. per standard ounce. The stocks are small everywhere. Little activity has been noticeable in the East. The backbone of the market is the requirement for coinage.

NITRATE OF SODA.—The question of restricting the output of nitrate has been postponed, and the negotiations among producers were abandoned at a meeting held at Valparaiso early in the month.

PRICES OF CHEMICALS.

February 9.

		£	s.	d.
Acetic Acid, 40%	per cwt.	2	5	0
,, 60%	,,	4	0	0
,, Glacial	,,	8	15	0
Alum	per ton	10	0	0
Alumina, Sulphate of	,,	14	0	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	31	0	0
,, Chloride of, grey	per cwt.	1	12	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	70	0	0
,, Phosphate of	,,	67	0	0
,, Sulphate of	,,	17	0	0
Arsenic, White	,,	29	0	0
Barium Chloride	,,	24	0	0
,, Carbonate	,,	5	0	0
,, Sulphate	,,	5	10	0
Bisulphide of Carbon	,,	30	0	0
Bleaching Powder, 35% Cl.	,,	16	10	0
Borax	,,	25	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	2	0	0
Copper, Sulphate of	,,	45	0	0
Creosote	per gal.		0	4
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			5
Iodine	,,		13	9
Iron, Sulphate of	per ton	3	5	0
Lead, Acetate of, white	,,	82	0	0
,, Chemical Sheet Metal	,,	38	0	0
,, Nitrate of	,,	68	10	0
,, Oxide of, Litharge	,,	38	0	0
,, White	,,	40	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	14	10	0
Oxalic Acid	per lb.		1	5
Phosphoric Acid	,,			10
Potassium Bichromate	,,		1	6
,, Carbonate	per ton	180	0	0
,, Chlorate	per lb.		1	7
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	53	0	0
,, Permanganate	per lb		5	6
,, Prussiate, Yellow (Ferricyanide)	,,		3	10
,, Sulphate, 90%	per ton	55	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	55	0	0
,, Bicarbonate	,,	6	5	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	0	0
,, Hydrate, 76%	,,	17	10	0
,, Hyposulphite	,,	17	0	0
,, Nitrate, 95%	,,	16	10	0
,, Phosphate	,,	22	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	12	6
Sulphur, Roll	,,	12	0	0
,, Flowers	,,	11	10	0
Sulphuric Acid, B.O.V.	,,	3	5	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tartaric Acid	per lb.		2	6
Tin Chloride (Tin Crystals)	,,		1	2
Zinc Chloride, solution 100°T.	per ton	32	10	0
Zinc Sulphate	,,	35	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3 202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,243,347
June	727,924	27,356	755,280	3,208,224
July	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122
November	753,605	27,408	781,013	3,317,534
December	755,101	26,010	781,111	3,317,949
Year 1915	8,772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846
May	2,416,966	25 8	17 0	8 6	1,031,220
June	2,346,493	26 1	17 2	8 8	1,017,908
July	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1914	1915	1914	1915
	£	£	£	£
January	249,032	293,133	128,862	143,649
February	259,888	286,879	123,169	144,034
March	273,236	299,686	131,392	153,770
April	295,907	315,541	131,697	149,978
May	290,062	318,898	145,227	142,123
June	306,421	322,473	147,289	135,289
July	320,670	336,565	152,923	140,290
August	316,972	344,493	150,386	139,364
September	309,398	321,085	154,316	135,744
October	337,241	339,967	159,410	141,771
November	311,711	313,160	154,674	122,138
December	309,669	331,376	147,699	158,323
Total	3,580,207	3,823,166	1,727,044	1,706,473

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
July 1915	555	98,859	98,757	419,495
August	1,079	99,941	104,258	442,900
September	2,019	100,833	93,764	398,282
October	2,346	100,238	102 609	435,853
November	797	99,206	103,670	440,360
December	2,883	96,997	101,309	430,333
Year 1915	17,277	1,192,790	1,210,067	5,140,189
January 1916	1,861	92,124	93,985	399,220

Production of Gold in Victoria and Queensland.

	Victoria.		Queensland.	
	1914	1915	1914	1915
	£	£	£	£
January	98,200	69,900	63,300	43,770
February	177,800	122,300	85,800	85,850
March	157,000	142,800	74,940	98,550
April	133,700	109,300	79,040	97,320
May	151,400	102,900	80,000	130,470
June	180,800	134,200	85,420	90,500
July	161,800	154,800	79,600	88,830
August	111,200	80,300	92,440	93,050
September	163,400	138,900	82,100	79,470
October	114,100	111,700	96,450	91,800
November	118,000	115,300	102,400	77,780
December	176,400	115,400	105,800	81,170
Total	1,743,800	1,397,800	1,027,290	1,078,560

Production of Gold in India.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	—
March	189,715	191,853	194,350	—
April	191,215	189,197	196,747	—
May	190,607	193,031	199,786	—
June	189,322	192,224	197,447	—
July	193,859	195,137	197,056	—
August	193,998	196,560	197,984	—
September	191,642	195,843	195,952	—
October	194,314	198,191	195,531	—
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	192,150

Daily London Metal Prices in £ per long ton.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard
Jan.	£	£	£	£	£
3	86¾	110	30½	88	171¼
4	87¼	111	31	88	174¼
5	88¾	112	31¼	88	174
6	91	114	32	88	175½
7	87½	114	32½	88	173¾
10	86	114	32	88	175½
11	85	113	31	89	173¼
12	85	114	29¼	89	173¾
13	87	114	29¼	89	174¼
14	85⅜	114	29¼	88	174
17	85⅞	114	29⅝	88	174
18	85⅞	115	30	88	173¾
19	85⅞	115½	30¾	88	175¼
20	87$\frac{7}{2}$	117½	31½	88	177½
21	89⅛	118	31⅛	90	179¼
24	91	120	31¾	91	180¼
25	91⅜	120	31⅞	91	179¼
26	90⅛	121	32⅛	91	178½
27	89⅞	122	32¼	91	177⅝
28	91⅛	122	32⅛	91	178⅜
31	92	124	32	91	178⅞
Feb.					
1	94⅝	124	31¾	90	179⅞
2	94⅝	125½	31⅜	90	178⅞
3	94⅞	127	31	88	178⅜
4	95⅞	128	31	89	180
7	97⅝	129	31¼	89	180
8	101½	131	32	89	179½
9	100	132	31¾	91	179¾

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1915	Jan. 1916.
	Tons	Tons.
Copper Ore	38,131	4,111
,, Matte and Precipitate	38,372	4,893
,, Metal (unwrought and part wrought)	180,368	12,679
Copper and Iron Pyrite	903,401	2,862
Tin Concentrate	44,748	101,890
,, Metal	38,896	2,074
Manganese Ore	377,324	32,111
Lead, Pig and Sheet	256,476	12,167
Zinc (spelter)	74,520	2,852
	lb.	lb.
Quicksilver	3,043,434	382,690

Stocks of Copper.
Reported by Henry R. Merton & Co. Ld. Long tons.

	Nov. 30, 1915	Dec. 31, 1915	Jan. 31, 1916
	Tons	Tons	Tons
Standard Copper in England	12,694	9,358	7,178
Fine Copper in England	878	1,763	1,573
,, ,, Havre	1,473	1,220	1,247
,, ,, Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*
,, Afloat from Chile	2,400	3,600	3,525
,, ,, ,, from Australia	3,500	4,000	4,000
Total Visible Supply	26,068	25,064	22,646
In other European Ports Estimated	500*	500*	500*

* As on July 31, 1914, but presumably present stock nil.

Exports of Copper from United States
Reported by United States Customs.

1915	Long tons	1915	Long tons	1916	Long tons
January	28,197	July	16,812	January	21,863
February	12,066	August	16,289		
March	29,725	September	14,327		
April	20,481	October	26,153		
May	25,785	November	19,396		
June	15,751	December	32,936		
		Total 1915	257,915	Total 1916	21,863

Stocks of Tin.
Reported by A. Strauss & Co. Long tons.

	Nov. 30, 1915	Dec. 31, 1915	Jan. 31, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	1,009	1,042	836
Ditto, Landing and in Transit	560	1,179	329
Other Standard, Spot and Landing	1,430	1,682	1,940
Straits, Afloat	2,138	1,077	1,765
Australian, Afloat	377	301	365
Banca, on Warrants	—	—	—
Ditto, Afloat	875	1,389	756
Billiton, Spot	—	—	—
Ditto, Afloat	—	50	335
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,954*	1,719*	1,105*
Afloat for United States	7,495	7,195	7,637
Stock in America	1,849	1,371	2,401
Total Stock	17,687	17,005	17,468

* Including 715 tons on board enemy's ships either captured or lying in neutral ports.

Shipments and Imports of Tin.
Reported by A. Strauss & Co. Long tons.

	Nov. 1915	Dec. 1915	Year 1915	Jan. 1916
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	1,838	777	23,330	1,540
Straits to America	4,050	3,565	31,565	4,205
Straits to Continent	825	959	11,024	350
Australia to U.K.	298	245	2,481	324
U.K., Holland, and Continent to America	1,030	965	14,967	1,352
Imports of China Tin into U.K. and America	27	110	3,012	65
Imports of Bolivian Tin into Europe	687	3,380	22,591	866

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915
	Tons	Tons	Tons	Tons
January	204	466	485	417
February	240	427	469	358
March	247	510	502	418
April	141	430	482	444
May	144	360	480	357
June	121	321	460	373
July	140	357	432	455
August	201	406	228	438
September	196	422	289	442
October	256	480	272	511
November	340	446	283	467
December	310	478	326	533
Total	2,540	5,103	4,708	5,213

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.

Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	—
March	3,196	3,562	3,839	3,653	—
April	3,904	4,066	4,087	3,619	—
May	4,277	4,319	4,135	3,823	—
June	3,472	3,993	4,303	4,048	—
July	4,234	4,245	4,582	3,544	—
August	4,454	4,620	3,591	4,046	—
September	4,115	4,379	3,623	3,932	—
October	3,905	4,409	3,908	3,797	—
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46.767	4,316

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1911	6151½	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
July 5, 1915	202	£18,721	£92 13 5
July 19	204½	£18,102	£88 10 5
August 3	177	£15,069	£85 2 9
August 16	171	£14,098	£82 9 0
August 30	156	£12,935	£82 18 5
September 13	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3
October 11	166	£13,620	£82 1 0
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0
December 20	181½	£16.941	£93 6 10
Total, 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18.122	£97 6 1
January 31	181	£18,023	£99 11 7

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	Jan. 31 1915	Dec. 31 1915	Jan. 31 1916
RAND:			
Bantjes	10	8	9
Brakpan	49	68	81
Central Mining (£12)	120	127	131
Cinderella	3	5	6
City & Suburban (£4)	49	42	40
City Deep	59	72	78
Consolidated Gold Fields	27	27	30
Consolidated Langlaagte	34	37	37
Consolidated Main Reef	19	20	20
Crown Mines (10s.)	79	62	64
D. Roodepoort Deep	16	14	15
East Rand Proprietary	29	21	21
Ferreira Deep	45	39	35
Geduld	21	35	37
Geldenhuis Deep	23	20	22
Gov't Gold Mining Areas	18	30	31
Heriot	55	60	47
Jupiter	3	7	7
Kleinfontein	19	27	30
Knight Central	5	15	14
Knight's Deep	25	30	25
Langlaagte Estates	18	19	20
Luipaard's Vlei	9	9	9
Main Reef West	6	6	9
Meyer & Charlton	106	119	120
Modderfontein B	91	117	122
Modder Deep	42	111	120
Modderfontein, New (£4)	260	315	324
Nourse	25	19	17
Rand Mines (5s.)	92	85	84
Randfontein Central	14	10	10
Robinson (£5)	41	26	26
Robinson Deep	24	24	22
Rose Deep	39	32	30
Simmer & Jack	9	9	10
Simmer Deep	1	2	3
Springs	16	37	41
Van Ryn	59	50	46
Van Ryn Deep	47	58	62
Village Deep	37	35	40
Village Main Reef	35	20	20
Witwatersrand (Knight's)	64	57	60
Witwatersrand Deep	39	27	26
Wolhuter	12	11	10
RHODESIA:			
Cam & Motor	16	14	13
Chartered	12	11	11
Eileen Alannah	9	11	10
Eldorado	14	11	11
Enterprise	6	5	5
Falcon	13	9	9
Giant	9	7	6
Globe & Phœnix (5s.)	32	27	26
Lonely Reef	25	25	24
Shamva	35	37	36
Wanderer (5s.)	2	1	1
Willoughby's (10s.)	6	5	5
OTHERS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	195	220	222
Glynn's Lydenburg	12	9	10
Jagersfontein	55	61	62
Premier Diamond Defer'd (2s. 6d.)	75	95	120
Sheba (5s.)	3	2	2
Transvaal Gold Mining Estates	39	25	25
WEST AFRICA:			
Abbontiakoon (10s.)	9	7	8
Abosso	9	9	10
Ashanti (4s.)	15	18	19
Broomassie (10s.)	2	½	½
Prestea Block A	12	8	8
Taquah	14	15	17
WEST AUSTRALIA:			
Associated Gold Mines	5	6	5
Associated Northern Blocks	5	5	5
Bullfinch	6	6	5
Golden Horse-Shoe (£5)	58	37	37
Great Boulder Proprietary (2s.)	15	15	15
Great Boulder Perseverance	2	1	1
Great Fingall	5	2	2
Ivanhoe (£5)	46	46	44
Kalgurli	34	16	15
Sons of Gwalia	21	15	15
Yuanmi	2	2	2

GOLD, SILVER, *cont.*	Jan. 31 1915	Dec. 31 1915	Jan. 31 1916
OTHERS IN AUSTRALASIA:			
Blackwater	15	15	15
Consolidated Gold Fields of N.Z.	11	11	11
Mount Boppy	11	14	14
Mount Morgan	46	39	38
Progress	7	5	5
Talisman	29	15	15
Waihi	39	35	35
Waihi Grand Junction	26	19	19
AMERICA:			
Alaska Treadwell (£5)	152	147	142
Buena Tierra	15	15	14
Butters Salvador	10	15	12
Camp Bird	8	7	7
Canadian Mining	9	10	11
Casey Cobalt	7	4	5
El Oro	10	9	9
Esperanza	9	11	10
Frontino & Bolivia	5	9	9
Kirkland Lake Proprietary	34	15	20
Mexico Mines of El Oro	86	80	77
Oroville Dredging	12	13	14
St. John del Rey	15	14	15
Santa Gertrudis	11	9	10
Tomboy	24	23	22
Tough-Oakes	14	12	12
RUSSIA:			
Lena Goldfields	29	29	29
Orsk Priority	—	14	15
INDIA:			
Champion Reef (2s. 6d.)	11	9	8
Mysore (10s.)	86	79	80
Nundydroog (10s.)	25	25	26
Ooregum (10s.)	24	23	24
COPPER:			
Anaconda (£10)	111	375*	350*
Cape Copper (£2)	50	50	50
Chillagoe (10s.)	½	[illegible]	[illegible]
Cordoba (5s.)	3	3	3
Great Cobar (£5)	4	2	2
Hampden Cloncurry	21	29	33
Kyshtim	45	36	35
Messina (5s.)	12	12	11
Mount Elliott (£5)	71	51	50
Mount Lyell	23	24	26
Rio Tinto (£5)	1150	1130	1135
Sissert	21	21	20
South American Copper (2s.)	12	12	14
Spassky	41	37	36
Tanalyk	47	31	34
Tanganyika	28	35	33
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	18	27	[illegible]
British Broken Hill	21	22	23
Broken Hill Proprietary (8s.)	23	48	48
Broken Hill Block 10 (£10)	22	19	17
Broken Hill North	39	42	44
Broken Hill South	117	137	135
Sulphide Corporation (15s.)	16	23	21
Zinc Corporation (10s.)	11	13	13
ASIA:			
Burma Corporation	30	32	33
Irtysh Corporation	—	34	34
Russian Mining	20	15	15
Russo-Asiatic	80	91	97
TIN:			
NIGERIA:			
Bisichi	7	6	6
Ex-Lands Nigeria (2s.)	1½	1	1½
Mongu	—	9	9
Naraguta	17	10	15
N. Nigeria Bauchi (10s.)	1	1	1½
Rayfield	4	4	4
Ropp (4s.)	19	13	14
OTHER COUNTRIES:			
Aramayo Francke	25	26	27
Briseis	5	5	5
Cornwall Tailings	10	5	[illegible]
Dolcoath	9	6	6
East Pool	—	7	11
Gopeng	26	29	29
Pahang Consolidated (5s.)	6	7	8
Renong Dredging	24	26	31
South Crofty (5s.)	42	6	9
Tekka	57	55	52
Tronoh	26	29	32

* Denomination of shares recently changed from £5 to £10.

THE MINING DIGEST

A PRECIS OF MINING TECHNOLOGY, DEVELOPMENT, AND LITERATURE

[In this department will be found listed the more important articles and miscellaneous publications appearing each month which deal with metal mining and non-ferrous mineralogy, the more significant publications being abstracted or reviewed. Copies of the originals can be obtained through the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.]

THE COAL AND IRON INDUSTRIES OF BELGIUM.

In *The Engineer* for January 14, H. Hubert, professor in the University of Liége before the war, commences a series of articles entitled: 'The Great Industries in Belgium before and during the War.' From an industrial point of view, Belgium may be divided into two parts, bounded by a line east and west from Visé to Tournai. To the north of this line the country is flat and is composed of Tertiary and Quaternary deposits, while to the south the country is hilly and consists of Carboniferous and older rocks. The Coal Measures have made the southern portion a great industrial and manufacturing region, and in the northern portion the plains of Brabant and Flanders are devoted to agriculture. In the eastern part, Campine, of the northern section, the soil is sandy and barren, so that agriculture is well nigh impossible, and the population is sparse. In this part coal deposits have recently been found by boring, and shafts are being sunk. The tendency therefore has lately been to move some of the industrial works from the southern region to the Campine district, especially works that throw destructive fumes into the air. For this reason zinc smelters have been erected in the district, at Overpelt, Lommel, and Baelen. This division into industrial and agricultural regions is of course not absolute, for machine shops and engine works are found at Malines, Tirlemont, Ghent, Louvain, and Bruges. The axis of the Coal Measures is indicated by a line through Liége, Namur, and Mons. The measures occupy a synclinal fold, the northern arm of which is at a gentle slope, while the southern is steeply folded back by the orogenetic action of the Ardennes mountains, and is in some places even overlain by Devonian beds. It is only recently that geologists recognized this structure, and encouraged the search for coal to the south of the

MAP OF INDUSTRIAL BELGIUM.

surface contact of the Coal Measures and the older deposits. The borings have disclosed valuable coal seams in Hainault, to the south of Mons and Charleroi, which will eventually add substantially to the coal resources of Belgium.

Professor Hubert mentions that the line dividing the agricultural and industrial regions also forms a line of demarcation between the two races that populate Belgium, the Flemish and the Walloon. The former are probably of German origin, and came from the north and east, and drove back the ancestors of the Walloon race, who however were able by means of the protection of the hills and forests of the Ardennes to check the further progress of the invaders. The Walloons are proud to point to the fact that Julius Cæsar records their resistance as the most stubborn that he encountered. The Flemings, though originally German, have for centuries fought for liberty, and have rivalled the Walloons in independence of spirit. Their breeding and their individuality in the arts and sciences have been differentiated throughout their history from the German.

The second of Professor Hubert's articles is published in the issue of January 21, and deals with iron and steel. The foundation of engineering industries in the southern region of Belgium did not depend originally on the coal resources, for the rich deposits of easily reducible iron ore found between the Sambre and Meuse rivers formed the basis of an iron and steel industry long before the value of coal was understood. The vast forests of the Ardennes supplied charcoal, and power was obtained from the mountain streams. Before the conquest by Julius Cæsar, iron implements were made in this region. In Charlemagne's days, a royal factory for armour and weapons of war flourished in the neighbourhood of Liége. During the thirteenth century the Liége iron makers invented the method of refining iron produced in the blast-furnace, known as the Walloon process, subsequently introduced into England, Sweden, and Germany. It was an Englishman, John Cockerill, who introduced the use of coke in blast-furnaces in Belgium, in the year 1821. He founded one of the great ironworks of the world at Seraing near Liége. These works have always been pioneers of progress. In 1855 the waste gases of blast-furnaces were utilized for steam-raising, and in 1895 the firm undertook the manufacture of gas engines to be operated by these gases. Just before the war, a gas engine of this type was built, developing 7000 horse-power. The iron industry was concurrently developed in the provinces of Liége, Namur, and Hainault. The local supply of ore began to fall fifty years ago, partly on account of the exhaustion of the mines, and partly because of adverse legal conditions in connection with the development of ore deposits. Of recent years Belgian ironmasters have largely employed ore coming from French Lorraine. During the year 1913, the output of pig iron in Belgium was 2,300,000 tons, and the output of steel was 2,466,000 tons.

MINING METHODS AT BROKEN HILL.

A paper is being presented at the February meeting of the American Institute of Mining Engineers by E. J. Horwood, of the Broken Hill Proprietary Company, on underground mining methods at Broken Hill. The extensive use of square-set timbering has been held as bad practice by some outside critics who consider that with a great continuous body such as is found here some modern method of eliminating timber should be adopted. For this reason we quote at some length the part of the paper dealing with this particular subject.

The varying physical character of the Broken Hill lode involves the employment of a variety of underground methods. The lode had its origin in an extensive fault plane traversing metamorphosed schists conformably, as a rule, with their beds of stratification. The underground waters carrying minerals in solution deposited their contents in the original cavities formed by the faulting action, and in the enlargements of these cavities due to dynamic forces brought to bear on the rocks, more especially on the hanging-wall side of the fault. This deposition was supplemented by replacement of a portion of the original rock contents by the argentiferous sulphides of lead and zinc which form the staple products of the district. Although the orebody is practically continuous, its width varies greatly, ranging from a few feet to about 350 ft. The widest portions occur in conjunction with huge folds in the enclosing country rock, almost exclusively on the hanging-wall side. The ore in these folds pitches to the south in the southern half of the district, and to the north in the northern half; there are, however, undulations in these ore channels evidently due to compression of the rocks in the direction of the channels. In the earlier days, before the orebodies had been opened up, vertical cross-sections across these bulges in the hanging wall gave the lode the appearance of the 'saddle formation'; but subsequent development of the ore channels has long since proved that they are not of this character. [We may here refer appropriately to the illustrated article by F. Danvers Power on the Broken Hill lode appearing in our issue of March 1915.]

The depth reached by the zone of complete oxidation of the sulphides varies from about 250 to 550 ft. from the original outcrop, while partial oxidation extends in places below the 1000-ft. level. The result of oxidizing influences has been the production of ore of every grade of cohesiveness, from that of dry sand to that of hard compact rock.

The methods of mining, even in individual mines, are varied in accordance with the character of the ore. The general practice is to sink vertical shafts, generally on the foot-wall side, free from the liability of disturbance from settlement due to stoping. Where there is an assurance of depth of orebody, the levels are spaced at distances up to 200 ft. This is considered the maximum for economical working, for, although the cost of opening each level per ton of ore commanded would be decreased by a further increase in the spacing, the extra cost due to extra wear and tear of chutes, reduced accessibility of the stopes, etc., would more than counterbalance that saving.

The largest shafts measure 13 ft. 8 in. by 9 ft. 6 in. within timbers, and are divided into three compartments, two for winding purposes, and one for ladderway and to accommodate air main, pump column, electric light and power cables, etc. Each winding compartment carries cages capable of holding two ore trucks, end on, each about 25 cwt. capacity; draft horses are also sent up and down in these cages at the end of each shift. Bearers, the ends of which are let into hitches cut in the solid rock, are placed about 50 ft. apart vertically, and below them, in addition to wood blocking, each wall plate is hung from that above by means of wrought-iron hangers, until the weight can be taken by the succeeding bearers. Strong frames are usually hung below the lowest wall plate to protect it from flying rocks, the result of blasting operations when sinking. The maximum distance of the timbers from the shaft bottom during sinking varies according to the nature of the ground.

The general practice in sinking is to employ four reciprocating rock-drills on two stretcher bars, and to arrange the holes so as to be able first to fire out a central cut across the shaft, after which the holes adjoining the cut are fired in succession by using varying lengths of fuses. A depth of about 6 ft. is gained with each firing. Electric firing has been tried on various occasions, but was not adopted because of the greater economy in explosives resulting from the use of time fuses, which enable the burden on the various holes to be successively reduced.

Where new shafts are being provided to command existing workings, the practice is to put up rises about 6 ft. square from the various available levels, subsequently stripping the sides to accommodate the shaft timbering. Rising is effected with the modern air-fed hammer drills using water, either through hollow steel or by means of sprays, to allay the dust. By this method shovelling is avoided; the expenditure in explosives is reduced; delays caused by baling water are eliminated; and power is saved in hoisting, since the broken rock can generally be used for stope-filling on the various levels. The general practice, except where the lode is narrow, is to place the extraction levels in settled country, at a safe distance from the lode on the foot-wall side. These are generally about 8 ft. wide, and carry double tracks. Where the orebody is wide, cross-cuts are run through the lode every 100 ft. Since the advent of the air-fed or telescopic hammer-drill, vertical connections have been made to a greater extent than formerly by rises instead of by winzes.

Where the ore is friable, and therefore not self-supporting, the square-set system is now universally adopted, using sets of sawn 10 by 10-in. Oregon pine, generally 6 ft. square and 8 ft. high from centre to centre. Because of several serious underground fires, attempts have been made, especially on the Proprietary mine, to replace this by a system of cross-cut or otherwise. In the former case, successive horizontal slices about 6 ft. wide by 7 ft. high were taken out and filled, and any drift timber used in the lower floor was drawn when the floor above was being stoped, tapered legs being used to facilitate this. Owing to the increased labour involved to both miners and shovellers, and the slow rate at which large bodies of ore can be worked, square sets were reverted to.

In places where the ore was sufficiently self-supporting, sloping stopes taking out slices 10 to 15 ft. wide were tried. The cost of handling the ore and waste filling was very low; but by reason of variations in the strength of the ground what appeared a perfectly safe width at one time might be unsafe later on; and this system was also discarded, except in isolated cases.

In using square sets for stoping these large masses of ore, it was the rule in the earlier days to work out the ore in stopes 100 ft. high. Although this has been successfully done in many cases, it is now held by those who have had the heaviest ground to work that in the long run it is much safer and more economical to divide the height into two lifts of 50 ft. each. When stopes as high as 100 ft. are worked, the accumulated shrinkage due to the drag of the filling on the timbering in the stoped-out ground is apt to leave considerable cavities between the old bottoms overhead and the top of the stope, rendering the blocking at the top of the stope useless. In some cases the old bottoms and filling above gradually subside and harmlessly follow the top of the stope below. In too many cases, however, there is a sudden drop of hundreds of tons on the top of the working stope, the effect of which may be its complete collapse, and great expense in making fresh arrangements to take out the ore. Much of the ore will have fallen into and mixed with the filling, besides being much more expensive to mine than if the collapse had not taken place.

Where the ore is sufficiently cohesive to make it possible to dispense with driving planks to support the back, overhead stoping is practiced, because the ground can be blasted to greater advantage, and with less explosives per ton, than in underhand stoping. In heavy ground, however, or where a slice of ore under old stope bottoms is being taken out, underhand stoping is employed, the miners first securing the ground immediately above the set or sets to be carried down, this securing being done with the aid of cantilever booms supported on posts set on the cap at the bottom of the set, driving planks being used if the condition of the bottom requires them.

With regard to the location and size of square-set stopes, the practice generally adopted is to carry the stope across the full width of the orebody, so that the stoping advances in the direction of the course of the lode, thus minimizing the effects of pressure on the stoping from the hanging wall, which, of course, becomes heavier as stoping proceeds. The extent to which stoping is allowed to advance before being filled depends on the prevailing conditions; but, in general, two sets wide by as many sets across the stope as possible are filled each time, leaving one vacant run of sets against the face. In the case of heavier ground, it is often necessary to fill the sets close to the working face, leaving single vertical gangways for the full height of face to give the required points of access to the face for re-starting the stoping.

The material most commonly used for filling is the residue from the flotation plants, but in the case of the Central mine, where there is much heavy moving ground and where filling is obtained cheaply from a quarry immediately over the workings, the use of tailing was discontinued. When tailing is used, as in the Proprietary mine, the sets are closely lined with 10 by 1-in. Oregon planks, and these are strengthened by two upright 10 by 2-in. planks wedged tightly between the caps. Where waste filling is employed, 5 by 1·5 to 2-in. laths spaced 4 in. apart are used, buttressed where necessary in the same manner as is done with the 1-in. planking. These buttress pieces are removed just prior to the filling of the succeeding stope. The bottoms of the square sets are covered with 2-in. planking, the space between which and the solid ore is filled with ore, to prevent breakage of the planking under the pressure of the overlying filling.

Where the sulphide ore is still in its original solid condition, free from decomposed veins and vugs, stoping is carried out without the use of square sets except for chutes and ladder-ways. The stoping begins at the various cross-cuts, and where these are not already connected by driving along the orebody, a stope about 20 ft. wide by 16 ft. high is carried each way, generally along the foot-wall, with a view to connecting with the adjoining cross-cut and establishing ventilation. The sill-floor stope is gradually extended until the entire width of the lode is stoped out for the height above mentioned. These excavations frequently exceed 100 ft. in width, and may in some cases attain a length of 300 ft. Pigsties, 5 or 6 ft. square, of 10 by 10-in. timbers crossed, are built from 12 to 15 ft. apart to support any ore likely to flake off. Excavations of this size are not common, as it generally happens that pillars of ground, either poor ore or country rock, occur that serve to support the back. A modification of the open-stope or bulkhead system of stoping was made use of on the Proprietary mine, where it was desired to obtain the maximum output of ore from a given length of lode; this applied particularly in exceptionally hard portions of the lode, where the cost of sinking winzes was excessive, and the lode had less than the usual width. The system may be described as an adaptation to lode mining of the long-wall principle in coal mining. Several floors of stoping are worked at the same time, access to each face from the main waste chute and ladder-way being preserved by the provision of timbered drifts connecting the waste chute with each stope. In this manner, any number of faces can be worked from each main waste chute, each on a separate floor, but the maximum number actually operated was four. The system was not extended, as the introduction of the Calyx drill enabled waste passes suitable for sand-filling to be provided at about one-quarter the cost of winzes. The holes bored by the Calyx drill were about 10 in. in diameter.

A certain amount of rill stoping has been practised where conditions favoured that system of work, but this is not usual. The hanging wall of the lode is oftener weak than strong, and constitutes a menace to the workmen employed on the sloping surface of the filling, especially when near the bottom of the rill where the danger is greatest, owing to the length of time the wall has been exposed. The nature of the filling generally available, namely, sandy tailing which never forms a compact surface, would necessitate the covering of the stope with planking to prevent undue mixing of broken ore with the filling. Further disadvantages as compared with flat back-stopes are the greater difficulty of rigging the rock-drills, and less favourable conditions for blasting, in that the ore usually lies in horizontal layers, and lastly, the disadvantage arising from the greater difficulty in breaking and keeping separate worthless material occurring in the lode.

UNDERGROUND MINING AT UTAH COPPER.

The application of steam-shovel methods on a gigantic scale at the mine of the Utah Copper Co. in Bingham Canyon, has tended to distract attention from the underground mining operations at that mine. The paper to be presented by Thomas S. Carnahan at the February meeting of the American Institute of Mining Engineers places on record some excellent work in connection with underground mining, and completes the information relating to the policy and methods adopted for developing this great orebody. In the early days underground mining supplied ore and also provided information relating to the nature and the extent of the orebody. Five years ago the knowledge of the orebody was sufficient to indicate that the ore could be mined in the cheapest way by a series of open benches up the side of the mountain, the ore being blasted and loaded into cars by steam shovels. For some time after this system was adopted, the shovels were engaged with the removal of barren capping, and in order to keep the concentrating plants occupied, supplies of ore had to be taken from below ground. Thus during the three years 1911 to 1913 inclusive, the amount of ore extracted was 3,071,719 dry short tons, and 102,719 ft. of development was done. Since April 1914 underground operations have been in abeyance. When this underground work was commenced five years ago, it was realized that it would be only an incident in the history of the mine, and that a method of mining should be adopted which would not interfere with the steam-shovel work. It was desirable that the surface should not be caved, that no large openings should be left unfilled, and that the capping should not be mixed with the ore. A system of shrinkage stoping was therefore adopted. Three levels were started by means of adits, in the positions shown in the diagram Fig 1, the lowest being the main haulage level. An underground shaft was equipped with hoisting apparatus for raising supplies from the main haulage roads to the two levels above, but the shaft was not used for lowering ore. The levels were connected by many manways and rises, and had more than one connection with the surface, good natural ventilation being thus maintained. Fig. 2 gives an idea of the manner of working the blocks of ore, and shows the central block of ore 500 ft. wide. This block was bounded, on the main haulage level by two parallel motor drifts, and on the upper levels by two main tramming drifts over those on the main level. To reduce the amount of timber required, and to leave substantial walls for the safety of future steam-shovel operations, the standard width of stope was fixed at 16 ft., with 44 ft. pillars between stopes. Subsidiary motor drifts were driven on the main level 50 ft. apart. At intervals of 60 ft. along these drifts, the centres of the stopes were marked. After stope-chute sets were put in place, pockets were cut on both sides. Rises at an inclination of 60° were put up from the pockets on each side until a height of 31 ft. vertically above the floor of the drift was reached, and from these points drifts were run horizontally, following the centre line of the stope. The drifts were thus extended right across the block. They were first made 8 by 8 ft,, and after their completion they were widened to 16 ft., by 4 ft. being taken from each side. As the subsidiary motor drifts were 50 ft. apart, it will be seen that there was no place along the floor of the stope floor more than 18 ft. from an opening for the discharge of ore. In alternate motor drifts inclined manway rises were put up in the pillars midway between stopes. When these rises had reached a vertical height of 31 ft., manway drifts were started at right angles each way to communicate with the stopes. At the junction with the stopes upward manways of timber were constructed partly in the wall of the stope and partly in the stope. The men and the air pipes thus reached the top of the broken ore in the stopes. The stopes from the main level were carried to the capping, or abandoned 10 ft. below the second level. In working the upper levels, cross-cuts were driven at intervals of 120 ft. at right angles to the main drifts. Each cross-cut was connected to the main level by two rises which came out on the cross-cut at 100 ft. from the main drifts. On both sides of these cross-cuts, stope drifts were driven at 30 ft. intervals, for a length of 30 ft., or 11 ft. beyond the centre line of the stopes. They were then enlarged sufficiently to accommodate the timbers for stope chutes. It was the practice to have the stopes on the top level worked out consider-

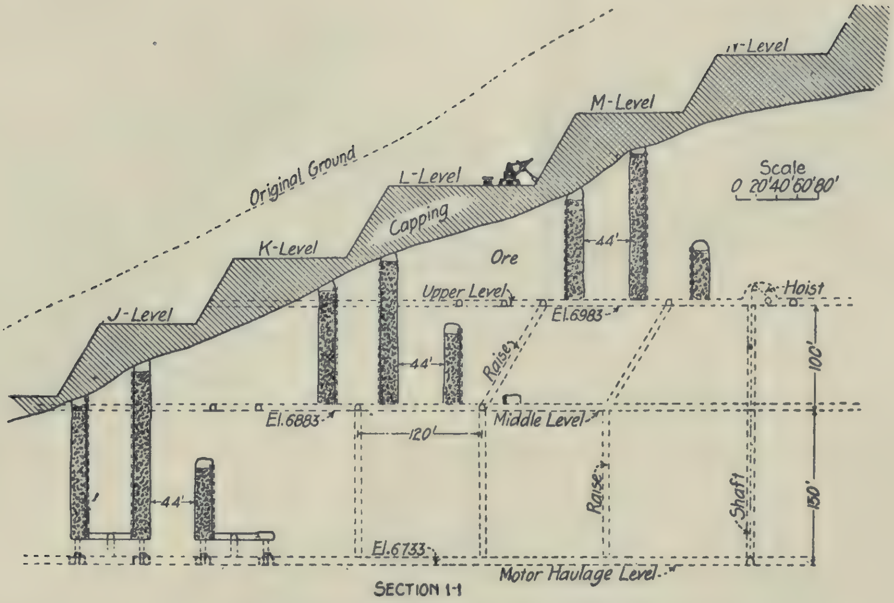


FIG. 1. VERTICAL SECTION SHOWING RELATION OF STEAM-SHOVEL MINING TO UNDERGROUND MINING AT UTAH COPPER.

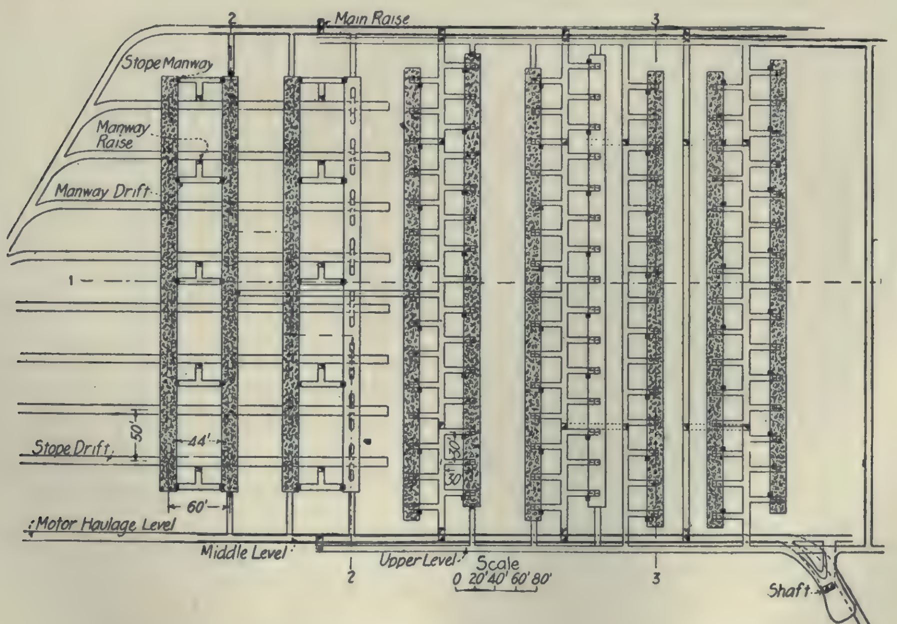
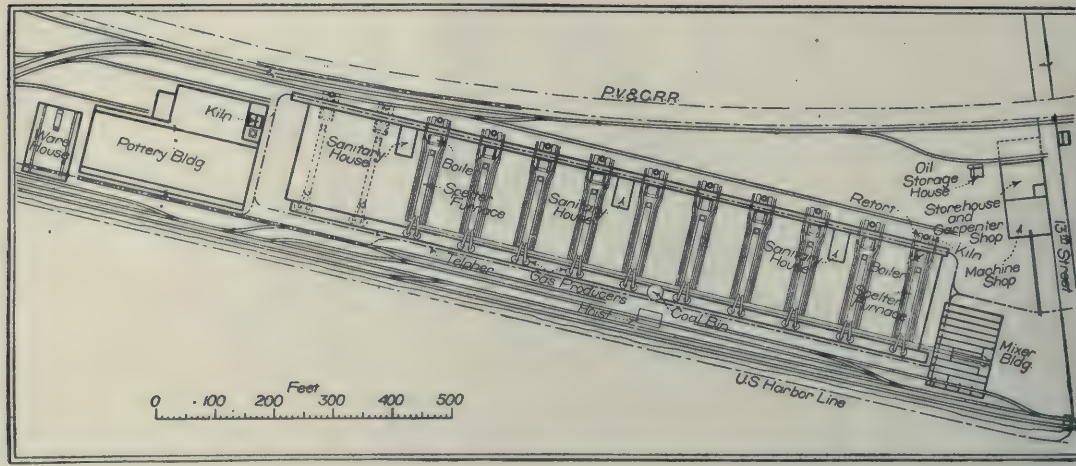


FIG. 2. PLAN OF UNDERGROUND WORKINGS AT UTAH COPPER.

ably in advance of the stopes started from the middle level. In this way the upper stopes were abandoned before the stopes from below began to disturb the tramming drifts and stope manways. This plan was necessary also in order to avoid cutting off the rises through which the ore was dumped from the upper to the main haulage level before the upper stopes were worked out. For the same reason the stopes started from the middle level were kept well in advance of those started from the main level. When the stopes were completed they were still nearly full of broken ore and none was drawn thereafter, so as not to leave cavernous spaces that would endanger subsequent steam-shovel operations. Thus only about 50% of the ore broken, or one-eighth of the ore developed, was extracted.



PLAN OF THE ZINC SMELTING WORKS AT DONORA,

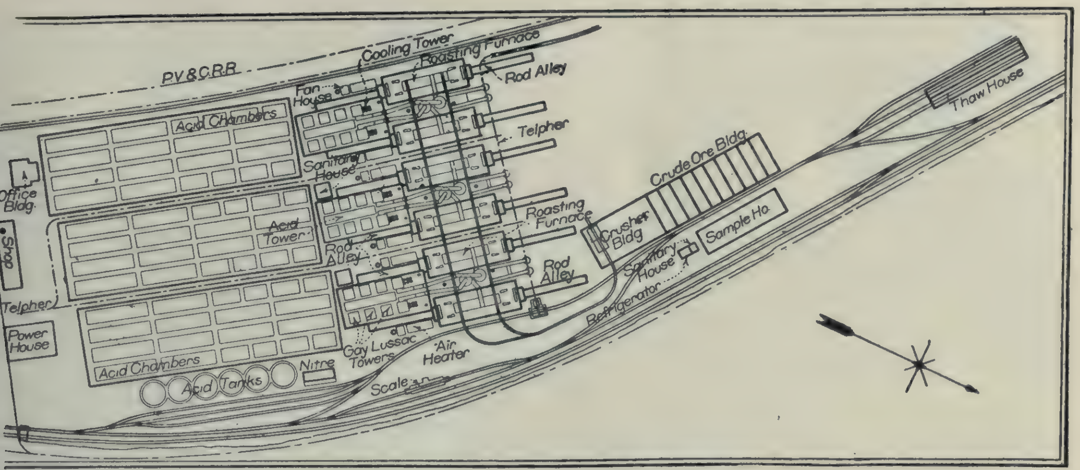
THE DONORA ZINC WORKS.

In normal years approximately one half of the spelter made in the United States is used in galvanizing, and the United States Steel Corporation, which is a large maker of sheets and wire, is one of the largest buyers of spelter. In the past, through the Edgar Zinc Company, it made a small part of the metal that was needed, but last year, finding its works dependent upon an outside and unfavourable market, the Corporation decided to erect new works of sufficient capacity to make it independent. It was at one time stated that duplicate plants would be built near Pittsburg and near Chicago, respectively, the combined capacity of the two being equal to the entire needs of the Steel Corporation, thus withdrawing entirely the largest buyer from the spelter market. For the present, at least, this larger programme is in abeyance, only the Donora works near Pittsburg having been constructed. This plant, which will have an annual capacity of 40,000 tons of spelter and 100,000 tons of sulphuric acid, was placed in partial operation within 104 days of the time a start was made. The works has a special interest for British readers, as the owning company has a contract with Amalgamated Zinc (De Bavay's) for 50,000 tons of Australian concentrate. Whether in normal times Australian concentrate will continue to flow to Donora is still a question, and it is stated that Montana is to be counted upon to supply any deficiency. The plans of the works herewith presented are taken from *The Iron Age* of January 7, to which publication we are also indebted for the following notes, condensed from the excellent description published by that journal.

A site of 40 acres was selected, situated between the Pennsylvania railroad and the Monongahela river and adjacent to the works of the American Steel & Wire Co., a subsidiary of the U.S. Steel Corporation. Water is pumped from the river and coal may be delivered by either rail or water, so that the engineering conditions are eminently satisfactory.

The ore is received in closed railway cars, weighed on track scales and dumped into bins, of which there are 10, each 70 ft. by 20 ft. by 16 ft. deep, and each with 2000 tons capacity. From storage the ore is taken by grab bucket operated by overhead crane to bunkers over rotary screens, from which the coarse goes to crushers and the fine direct to cylindrical driers, and so to bins. The roasting furnaces, six in number, are of the Hegeler type, seven floors, double, each hearth 26 by 20 ft., and with a total hearth area per furnace of 6800 sq. ft. Each is heated with gas from a mechanical producer rated at 2000 lb. coal per hour gasified. Waste heat is used to pre-heat the air. About 55 tons of ore per day is roasted, or 16 lb. per square foot of hearth area, with a coal consumption of 12 to 15 tons. The acid works are contained in three buildings, constructed of steel and fire-brick tile. The tower building is 71 by 150 ft. and the chamber building 138 by 400 ft. The roasting gases pass through a centrifugal gas chamber 30 ft. high and 20 ft. diameter. From this they pass to a tower, then through 10 lead chambers having a volume of 360,000 cu. ft., then through towers (14 by 14 by 40 ft.) packed with special chemical brick. There are six steel storage tanks on reinforced concrete platforms, each having a capacity of 1250 tons.

By means of a mono-rail telpher system, the roasted ore is taken to the mixing room and stored in reinforced concrete bins. As needed it is taken by overhead crane to cars with weighing bins. When the proper amount of coal has been added, the charge is passed through mixers to charging cars, and so to the distilling furnaces. Of these there are 10 (four now in operation), each containing 912 8-in. retorts. Each furnace has a capacity of 10 tons in 24 hr., and each has 2 mechanical producers of 10 ft. diameter to furnish the gas. The furnaces are parallel on 95-ft. centres, each building 70 ft. wide, leaving 25 ft. between for light, air, and rest rooms. The buildings are made of asbestos-covered steel. Waste gases are used in a 588 hp. vertical boiler. The pottery includes a 66 by 128-ft. manufacturing room with a 121 by 289-ft. dry room. It is of usual type and has a capacity of 1000 retorts and 300 condensers for 24 hours. The power-house is 57 by 80 ft., but includes no generators, as current will be furnished from the adjacent works of the American Steel Wire Company. A thaw-house for incoming ore in winter is still to be built. Excellent sanitary and safety arrangements have been made throughout the plant.



PENNSYLVANIA, ERECTED BY THE UNITED STATES STEEL CORPORATION.

ACCIDENTS DUE TO EXPLOSIVES IN MINES ON THE RAND.

The November *Bulletin* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by Charles E. Hutton entitled: 'The Chief Sources of Accidents in the Witwatersrand Mines.' Mr. Hutton is a Government Inspector of Mines, and has done much to arouse interest in methods of preventing accidents. A few months ago he gave a series of public lectures with this end in view. In the present paper he takes the official returns of accidents during 1914, analyses their causes, and gives some hints for their prevention. We extract herewith his remarks relating to accidents arising from misadventure with explosives. During the past year we have quoted writers on this subject, notably Cullen and Marquard, and we offer no apology for reverting to it now, for the intelligent employment of explosives underground deserves special study. Mr. Hutton gives the following table of causes of accidents during 1914:

Causes	Separate Accidents	Persons Killed	Persons Injured
1 Drilling into misfire	99	97	98
2 Gassing	14	17	6
3 Premature Explosion	4	7	3
4 Charging up	8	9	6
5 Struck by flying stones from blasting	21	9	13
6 Sundry	12	7	11
7 Handling detonators	30	—	30
	188	146	167

It will be seen that 66% of the deaths were caused by holes being drilled into misfires, and it is obvious therefore that the prevention of misfires requires investigation. Misfires can be divided into two classes: partial and complete. As regards the causes in the first case, when one or two cartridges are left at the bottom of a hole unexploded, it is necessary to appreciate the fact that the blow given by the detonation of the cap in the primer must be sufficiently strong to bring about the perfect detonation of the whole charge. The explosion of a charge does not take place progressively, that is, one cartridge firing the next and so on, but takes place instantaneously. With a weak cap an explosion may be obtained, but its effect will not extend to the end of the charge, with the consequent result that a cartridge or two remains unexploded in the bottom.

Makers of explosives state that the blasting gelatine and gelignite used on the Rand are capable of complete detonation if the miner does his work properly and uses sound detonators. It is therefore evident from the large number of partial misfires that either the miner fails to do his work properly or the detonators are at fault. It is known that the detonating strength of a cap is adversely affected by dampness, and that a weak cap will explode a portion of the charge only. As the mine air nowadays is to some extent charged with moisture, detonators when stored underground may after a time be affected, and therefore should not be used if stored for a longer period than, say, a fortnight.

In regard to faulty work of the miner bringing about a misfire, there are two essential points: firstly, the cartridges must be inserted one by one and pressed firmly home by means of the wooden charging stick so that the bottom cartridge is in direct contact with the bottom of the hole and each cartridge is in close contact with the next adjacent, leaving no air spaces whatever; tamping materials should never be inserted between cartridges (Regulation 106, 22) for the reason that the detonating force of the cap may not be sufficient to pass through this intervening tamping. The second point is that Regulation 106, 19, must be strictly observed. This Regulation insists that the fuse with its attached detonator must be securely fastened to the primer so that it cannot be inadvertently withdrawn. If this is not done there is always the chance of the capped fuse becoming detached from the primer to such a distance that the cap cannot possibly exercise its full detonating influence on the whole charge, with the result that a partial misfire is recorded. Miners frequently, instead of tying, press the cap deeply into the primer to secure firmness; to bury the detonator thus is one of the causes of the production of dangerous fumes, as the fuse side-spits and sets fire to the cartridge before the cap explodes.

Very few accidents can be attributed to drill holes intersecting holes in which the charge has utterly failed to explode, as such holes are usually easily detected and so avoided, excepting, perhaps, the 'cut-off' hole. The cause of complete misfires may be due to (*a*) faulty manufacture of the fuse in the form of an interruption in the continuity of the gunpowder core; (*b*) in not tapping-out all the sawdust in the detonator before inserting the fuse; (*c*) in failing to securely tie the capped fuse to the primer, so allowing it to become completely detached from the primer; (*d*) cut-offs caused by the fuse of a charge being destroyed by flying stones from a blast nearby, or an adjacent blast tearing away the collar of the hole and in so doing removing completely the fuse and possibly the primer, and perhaps one or two sticks of the charge itself. It should be possible to minimize to some extent the number of cut-offs by tucking the fuse into the hole and so giving it protection.

Accidents attributable to previous misfires occur in all working faces, stopes, drives, winzes, shafts, and rises. In the stope faces, 66 persons were killed and 60 persons severely injured during 1914 through jumpers coming into contact with misfires. A great fault of gangers is frequently noticeable in that benches are not cleaned down as they should be before a hole is pitched. Many times the author has seen machine holes being drilled on benches with a large quantity of rock from the previous blast lying on the faces, the gangers apparently never troubling to clear away more than was necessary to make space for the pitching of the hole to be drilled. Similarly in hand stopes the benches have not been cleaned down thoroughly before drilling commences.

It may be claimed by the miner that he has not sufficient time to clear his working benches of all dirt, but it may be suggested that if each 'boy,' whether on hammers or machines, be made to understand that no drilling would commence until the bench faces are scraped properly clear, this understanding itself would induce the natives to hasten this work, and drilling would in no way be delayed.

It is perhaps not always possible to make sure of the direction of sockets, neither can one be certain of their depth, and as there is always the chance of their containing explosives, the obvious thing to do is to avoid them like poison and start the nearest hole as far away as possible. There is little excuse for the miner to fail in detecting sockets of holes on benches when making his examination, more particularly so if his working place is run on single shift.

Dealing with accidents in development work, no less than 31 were killed and 39 injured through misfires being drilled into during 1914. Sockets of holes are always present in development faces after a blast, any one of which may be a misfire in a sense that a portion of the charge may have failed to explode and remained sticking in the bottom. It is sometimes difficult to detect sockets in development ends owing to the fact that the holes, being relatively close one to the other, when blasted are very apt to close the socket so completely that their discovery is troublesome, and for this very reason a new Regulation was framed to deal with this difficulty. This Regulation, 100, 13, demands that before drilling is commenced in any shaft in the course of sinking, and faces of winzes and dritfs being advanced, the ground must be blown over with compressed air or water under adequate pressure, so as to expose all misfires and sockets. This Regulation, though excellent, does not go far enough, for it fails to state that the sockets themselves must be washed out so that their direction may be ascertained. This Regulation came into force at the end of 1913. Comparing the recorded accidents brought about by misfires in development ends in 1914 with previous years:

	1912	1913	1914
Deaths.............	74	56	31
Footage cut......	823,400	791,100	718,500

it would appear that the Regulation has been carried out with some success. The evidence of the 31 deaths, however, shows that this blowing-over has not been carried out effectively by all miners.

Accidents due to gas poisoning frequently occur in the mines, caused through the mine air being contaminated by the fumes produced by: (1) Incomplete detonation of explosives, and (2) accidental burning of explosives.

With complete detonation the only harmful gas given off is carbon dioxide, and medical officers state that this gas is never the cause of fatal gassing accidents in Rand mines. It can be safely said, however, that complete detonation rarely takes place. With incomplete detonation the two dangerous gases, carbon monoxide and nitrous fumes, are produced in various quantities, depending on how close the detonation is to theoretical perfection. On the assumption that carbon dioxide, carbon monoxide, and nitrous fumes are always present in varying amounts, it would appear at first sight that gas poisoning must be expected in a greater or lesser degree, but this is not so if ordinary precautions be taken. In the first place there is not the slightest fear of gas poisoning happening in workings that have thorough ventilation. There is no record of any gassing accidents having occurred in such places from incomplete detonation of charges. Fatal gassing accidents invariably occur in or near development ends, and occasionally in back stopes. If the Regulations in respect of the ventilation of winzes and water blasts be observed, and back stopes be furnished with compressed air lines, gassing accidents would be a thing of the past.

During 1914, 17 persons lost their lives through gas poisoning, and in each case the accidents occurred in development ends; in 1913 there were 51 deaths. Gassing accidents happen more frequently in winzes than elsewhere. After blasting in the bottom, the air in the winze will contain varying percentages of carbonic acid gas and carbon monoxide, and perhaps nitrous fumes. Because of the presence of carbonic acid gas, which is heavier than air, this mixture will remain in the lower part of the winze. To descend into the winze, therefore, after a blast would be dangerous unless these gases are dispelled. The dispelling of these gases is provided for by two Regulations. Regulation 62 insists that every winze shall be provided with adequate means of ventilation whereby any foul air at the bottom may be expelled; and that the air pipe down the winze used for blowing-out the foul air shall be fitted with only one cock, and this cock to be at the top of such winze; and, further, no person shall descend until the foul air be expelled. Regulation 106, 34, demands that the ganger shall, immediately after lighting up, put into action the water-blast, which he shall previously have tested. Carbonic acid gas, and more particularly nitrous fumes, are soluble in water, but carbon monoxide can only be got rid of by ventilation. The effect of the water-blast is threefold: (1) Nitrous fumes rendered harmless; (2) displacement of gas by the induced fresh air; (3) allaying dust. If these three regulations are properly observed no gassing accidents should ever occur in winzes.

A frequent cause of gassing accidents is due to natives entering development ends and setting about their work before their boss arrives, and the fumes of the previous blast not having been expelled. In these cases the natives are themselves at fault. But at the same time the ganger is in all probability also guilty, for it is his duty to see that the natives working under him appreciate the danger attending the contravention of Regulation 100, 11, which reads: "No person being the member of a gang under the charge of a ganger shall, either at the beginning of a shift or after blasting, enter the working place until he has received definite instructions so to do from such ganger."

Mr. Hutton proceeds to discuss gassing accidents due to accidental burning of explosives. A great number of accidents have occurred on the Rand through explosives having been set on fire accidentally. To show what can happen when nitro-glycerine compounds are burnt, he gives an account of the disaster at the Driefontein Consolidated on March 28, 1907. This accident happened at the Farrar shaft at about 11 p.m., resulting in the death of six white men and 53 natives. All these persons were waiting at various stations to ascend at the end of the shift. Some gelatine was at that moment accidentally set on fire on the No. 11 level. It appears that a miner, while locking his gelatine box, by some means set fire to the contents, which flared up and generated heat to such a degree that the remaining gelatine exploded. Death was caused in most cases from gas produced by the burning gelatine.

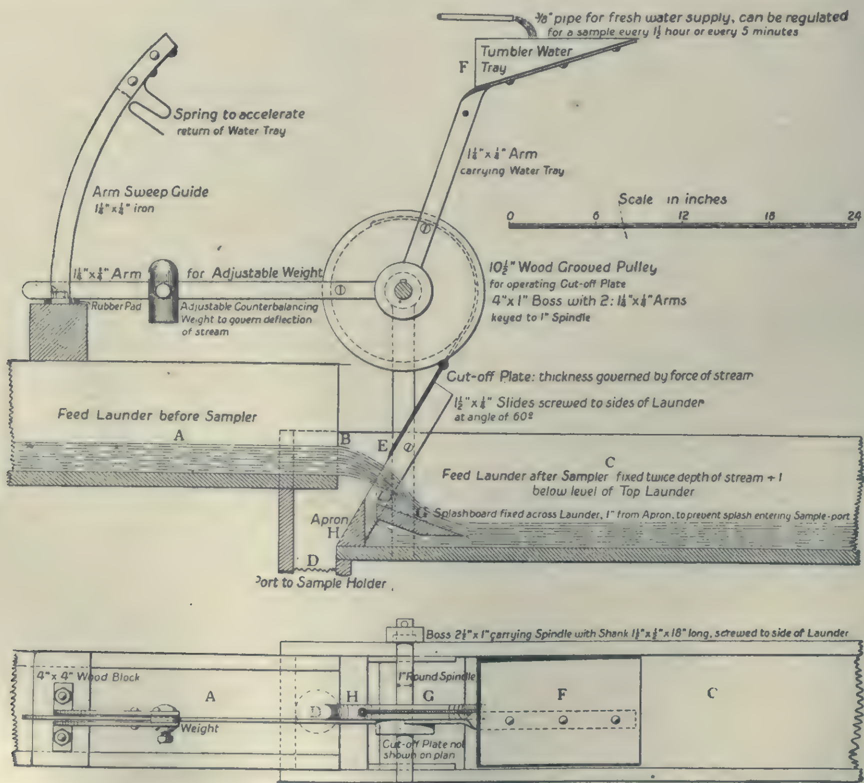
To show how these gases can drift with the ventilation and find victims hundreds of feet away from the site of the burning, Mr. Hutton quotes particulars of a disaster that occurred on July 21, 1910, at 8 a.m., in the workings of the Hammond shaft of the Simmer East, which resulted in the death of one white man and 25 natives. This accident was caused by the carelessness of a miner dropping a lighted candle into his 'explosives box' on the 14th level. This explosives box contained 50 lb. of gelatine. The current of air on the 14th level was fairly strong and carried the fumes through a stope up and along the 13th level, where it split, going east and west. The effects of the fumes were felt on the east side for 750 ft., and on the west side for over 750 ft., and on both sides it found its way to No. 12 level, through stopes from which, fortunately, all persons had been removed. Had the officials not been alert many more deaths might have been recorded.

SMELTING AT THE BRADEN COPPER MINE.

Teniente Topics for November contains an account of the smelting operations at the Braden copper mine. The mine is situated to the south of Santiago, Chile, and the newspaper we quote is a bright little monthly magazine published by the staff of the company. The Braden is one of the Guggenheim enterprises, and with its stable-companion, the Chuquicamata, has revived the importance of Chile as a copper-producing country. The present Braden company took possession in 1909, and was at first confronted with many difficulties in connection with labour and former methods of mining and smelting. The smelting plant then consisted of two circular blast-furnaces, and a series of conical roaster-sinterers. There were no converters, and the matte was shipped to New York or Liverpool. The material treated was chiefly table concentrate, with a small proportion of vanner and buddle slime. Half was sintered and half smelted direct. The installation was typical of a great number of establishments scattered throughout Chile. Work during 1910 was interrupted many times for various reasons, such as shortage of supplies, power, and labour. In 1911 the two circular furnaces were dismantled, and a rectangular furnace 36 by 84 in. was built instead. As the segmental water-jackets were employed in the construction of the new furnace, the latter had an odd-looking scalloped shape. In the meantime, a new smelting plant on modern lines was being erected. The first of the new furnaces measured 48 by 180 in., and it was started in December of that year. It was afterward lengthened to 300 in. A full-size Peirce-Smith converter with 33 tuyeres was also erected, and a briquetting plant. The converter proved too big for the amount of matte produced, so it was divided into two by a brick partition. The briquetting method was also found unsuitable. The production of blister copper during 1912 was 4700 tons, extracted from 34,000 tons of concentrate. Early in 1913 flotation was adopted, and since then the proportion of fine concentrate has increased. A second blast-furnace and another half-size converter were added in the same year. During 1913 the production of blister copper was 9100 tons, obtained from 61,000 tons of concentrate. In 1914 briquetting was abandoned, and a sintering plant and nodulizing cylinders or kilns were introduced. The sintering plant has a capacity of 50 tons per day. By its means the sulphur content of the concentrate is reduced from 28% to 12%, and the product is a hard cake, suitable for the blast-furnace. The nodulizing cylinders are, however, the feature of Braden practice. The first to be built was 8 ft. diameter by 80 ft. long, inclined 1 in. per ft., and making one revolution per minute. Two others were subsequently added, each 50 ft. long, and a fourth 100 ft. long is under construction. These kilns are heated by oil-fuel, the burner being at the discharge end. The effluent gases go to settling chambers, and the dust caught there is returned to the nodulizing furnaces or sent to the sintering machine. During the nodulizing process, the sulphur content is reduced from 28% to 18%. The production of blister copper during 1914 was 14,200 tons, obtained from 88,000 tons of concentrate. During 1915 the metallurgical equipment has been still further improved, and at the time the article quoted was written, comprised two blast-furnaces, 300 in. and 360 in. long respectively, and three Peirce-Smith converters, two with 33 tuyeres and one with 17 tuyeres. The production of concentrate is 350 tons per day, the average content per cent being: copper 19, iron 23, sulphur 28, lime 2, silica 17, alumina 8. Of the concentrate 215 tons goes to the nodulizing roasters, 50 tons goes to the sintering plant, and 85 tons is fed direct to the blast-furnaces. The dust from the nodulizing kilns and the blast-furnaces is returned, partly to the nodulizing kilns and partly to the sintering furnace. In the blast-furnaces the flux consists of converter slag, which averages 60% iron, 8% silica, and 4% copper. The consumption of coke in the blast-furnaces is 60 tons per day, and of the oil-fuel in the nodulizing furnaces 10 tons. The 350 tons of concentrate is obtained from 4000 tons of ore, and the daily yield of copper is 60 tons, so that the extractable content of the ore is 1½ per cent.

TAYLOR'S PULP-SAMPLER.

At the January meeting of the Institution of Mining and Metallurgy, W. H. Trewartha-James described a form of pulp sampler invented by M. T. Taylor, the manager, for Bewick, Moreing & Co., of the East Pool mine in Cornwall. The accompanying illustration shows its principle and details of its construction. The pulp passes from the launder *A* to the launder *C*, and at pre-determined intervals the cut-off plate *E* descends and deflects the stream into the sample-port *D*. The descent of the plate is governed by the tumbler water-tank *F*. This tank is fed from a small water pipe and when full falls to the right and empties itself. While the tank is down, the plate *B* is also down, and deflects the pulp into the passage *D*. On the discharge of the water, the counterbalancing weight shown restores the tank to its original position. The interval between the descents of the tank can be regulated by the rate of flow of water into it, and the length of time it is down can be regulated by varying the rate of discharge from the tank. At East Pool the slide is down for a second every five minutes. Where the pulp pours into the launder *C*, a board *G* is arranged to prevent splashing, and the apron *H* is fixed as shown so as to prevent any pulp that works back from entering the sample-port *D*. The plate *E* works in slides, and the force of the pulp presses it upon them so that no part of the current can escape into the launder *C* while it is down. In this way a true sample is obtained, and this point is an important feature of the design. Another noteworthy feature of this design is that a very small fall is involved, the vertical distance between the two launders being only a little more than double the depth of the pulp. Thus the sampler will be easily fitted in mills where there is not much fall. The only objection to be urged against the design is that as the slide enters the top of the pulp first and leaves it last, the top is sampled for a longer time than the bottom, and that, in consequence, the sample does not represent all parts of the flow equally. With a shallow flow, say three inches, this effect is negligible. By contracting the discharge mouth at *B* by means of wedged-shaped pieces of wood, a churning action will be caused, which will intimately mix the various layers in the pulp and make its constitution homogeneous. An advantage that can be claimed for the machine is that it is exceedingly simple in construction. The machine is not patented.



VERTICAL CROSS-SECTION AND PLAN OF TAYLOR'S PULP-SAMPLER.

An Air-fed Stoping Drill.—In the *Mining and Scientific Press* for October 30 last, E. G. Snedaker described a method developed at Cripple Creek, Colorado, for adapting air-fed stoping drills of the hammer type to driving drifts. This was accomplished by means of an A-frame sprag resting on a movable platform, and which furnished something for the drill to push against. The same problem had been under study in the southeastern Missouri lead region, where a home-made device for mounting the hammer-drills on a column bar had been worked out. In the *Mining and Scientific Press* for November 20, Frederick W. Copeland describes a mounting built by the Sullivan Machinery Co. along the lines developed in Missouri, and in *Mine and Quarry* for January full details of the mechanism are published. Briefly, a saddle is provided for mounting a rotating hammer-drill with water-jet attachment, it being only necessary to detach the usual throttle valve, place the drill in the saddle and tighten three bolts. The saddle rests on an off-set arm from a piston which, with its cylinder, is mounted on a light column bar or arm. The controlling valve is in the off-set arm and admits air both to the drill and to the mounting piston. By suitable simple manipulation of the valve, the rates of forward and back feeding as well as drilling are easily controlled. A mechanical brake is also provided to meet difficulties in drilling certain sorts of ground. The net result is an automatically fed and rotated air-drill of one-man weight. In ground of even hardness the machine man can start it going and then pick out his steels or do any other necessary work while it drills up to the end of the steel. In irregular ground a very flexible control is provided. The off-set arm and the use of air to pull the drill out, as well as to feed it forward, afford a means for quick changing of steel and facilitates the use of irregular lengths, and so shortens the time lost. By drilling under as well as over, it is possible to put in the holes 18 in. apart from one mounting, and by various other short cuts a whole round may, under favourable conditions, be drilled from one set up. The net result is to increase the effective drilling time, which is the main avenue to progress these days now that the actual work of drilling has been so markedly speeded up.

Labour at Messina.—Figures regarding the native labour situation in the northern Transvaal in 1915 were contained in a report made to the Messina (Transvaal) Development Company, Ltd., by Mr. A. F. Kuehn and are here abstracted by permission.

At the Messina, in the financial year ending June 30 last, an average of 92 white men and 1157 natives were employed. The natives are of three different stocks, and there is considerable difference in the percentage of old boys available from each. The figures for five months were as below:

	North of Limpopo	'B. Vendas,' Transvaal	'Shanagans,' Transvaal
Approx. percentage of total	63·5	30·5	6·0
New boys hired, %	80·6	15·3	4·1
Old boys hired, %	42·1	53·6	4·3
Old boys in total hired, %	20·0	63·0	35·8
Loss, % on number at end of month	8·6	7·2	6·8

The boys from north of the Limpopo represent the tropical tribes. The 'B. Vendas' represent the boys commonly used on the Rand, while the 'Shanagans' are Zulu-like if not of Zulu stock. While the men are lost in nearly equal percentage, more tropical natives are available than any other, and the 'B. Vendas' furnish the largest percentage of trained men. Wages range from 8d. per shift, for work in cleaning up at the surface, to 1s. 11d. for machine drill boys. The average per shift in the mine is 1s. 7d., at the surface 1s. 10d., and general average 1s. 4d. To this must be added for bonus and overtime 0·6d., food 3·1d., administration of compounds 1·8d., making an average total cost per shift of 1s. 9·5d. With such mixed crews the tons hoisted per month in 1914-15 amounted to 7689, with 1157 boys on the pay roll. At this time the average number in the mine was 496, at the surface 544, on sick leave 72, and idle 45. The efficiencies for three years were as below:

	Tons per average boy per month		
	1912-13	1913-14	1914-15
Mill and surface	6·85	11·05	14·30
Mine	8·65	13·30	15·50
General average	3·47	5·12	6·63

Substitutes for Platinum. — The January issue of the *Bulletin* of the American Institute of Mining Engineers contains a voluminous paper by F. A. Fahrenwald, describing researches for substitutes for platinum alloys, undertaken on behalf of the National Dental Association of America. The author states that 33% of the platinum used in America is in connection with dentistry. When employed in the form of foil the platinum may be used pure, but when required to be harder an admixture with iridium is desirable. The details of the paper need not be given here, as they are of limited interest to our readers. Briefly we may say that as substitutes for pure platinum the author finds that certain alloys of silver and palladium, and gold and palladium give satisfactory results. As regards harder metal, pure ductile tungsten and molybdenum possess many of the characteristics required. By themselves they have the disadvantages of being easily oxidized and of not being readily soldered. The author found, however, that these disadvantages were obviated by coating them with a precious metal or alloy. Attempts to form alloys of tungsten and molybdenum with precious metals have not so far borne fruit, but the line of research offers a certain amount of encouragement.

Concentration and Metallurgy at the Falcon Mines. — The smelter at the Falcon mines, to the east of Gwelo, Rhodesia, constitutes virtually the first venture of the kind in the central and eastern portions of British territory in South Africa. Copper smelting is an old business in the western part of the Cape Province. Other notable smelters have been established at Otavi in 'German' South-West Africa and in the Belgian Congo. The smelter at Kansanshi in Northern Rhodesia was not in operation for long. It is appropriate that we should quote the references to the concentration and smelting plant contained in H. A. Piper's yearly report to the company issued this month.

The sulphide ore averages in round figures 6½ dwt. gold and 2½% copper. The copper mineral is disseminated throughout the silica of the lode, and is also found in the schistose wall-rock. The ore is crushed by Nissen stamps, half of which crush to pass ⅛ in. opening and the other half to $\frac{3}{16}$ in. opening. The crushed ore, after some has been removed by hand-picking, is treated on Record vanners, the tailing from which goes to tube-mills and thence to a second set of Record vanners. The tailing from the second vanners goes to blanket tables, which are useful in saving fine free gold. The tailing from the blankets is separated in cones into sand and slime, and the slime overflow is dewatered by Dorr thickeners. The sand and dewatered slime are mixed and delivered to Minerals Separation flotation plant. The results of concentration during the year ended June 30 last show that 61·6% of the gold and 35·2% of the copper in the ore was recovered by the vanners and blankets. In the Minerals Separation plant a further 15·8% of the gold and 56·8% of the copper was recovered, so that the total recovery was 77·4% of the gold and 92% of the copper.

The smelting plant consists of two blast-furnaces, which are used alternately, two converters, and twelve sinter pots. The sintering apparatus treats the coarser concentrate, together with some of the Minerals Separation concentrate. The bulk of the latter was fed at first to the blast-furnace direct, as the draught there was less likely to carry the material away than in the sinterers. The addition of ironstone and converter slag in the sinterers has made it possible to treat more fine concentrate in this way, and eventually the bulk of the concentrate and all the flue-dust will go to the sintering plant. The oxidized ore contains 6 dwt. gold and ½% copper and it is not amenable to cyanide. It is to be concentrated on vanners and blankets and the concentrate sent to the smelter.

Copper in Yunnan, China. — In the *Far Eastern Review* (published at Shanghai) for November, V. K. Ting, director of the Geological Survey of China, gives a historical account of the copper mines in the northeastern part of the province of Yunnan. These mines are near Tung-chuan on the upper Yang-tse-kiang, and not far from the border of the state of Sze-chuan. The provinces of Yunnan and Sze-chuan are separated by mountains, which are the southern extension of the Talianghan range. Between these mountains and the Yang-tse-kiang there are copper mines near Tiechang. To the east of the Yang-tse-kiang, in the high ground between the river and its tributary, the Hsiao-kiang, which enters to the north, is to be found another group of copper mines, at Tangdan, Loshue, Tasui, and Moulu. The Tangdan is much the largest copper mine in the province. The ore is chiefly chalcopyrite, but bornite and chalcocite are also found. The lodes occur in metamorphosed Cambrian shales and sandstones, and also in Carboniferous limestone. In some cases the deposits are in the form of stockworks. Records show that the mines have been in existence since 1697. From 1738 to 1858 the output was bought by the Chinese Government at Pekin, and the copper was used for coinage purposes. From 1858 to 1874, the Mohammedan rebellion put a stop to all mining in Yunnan, and since the latter year operations have been conducted on a smaller scale under varying control and conditions. Investigations are now being made by government with a view to improving the methods and increasing the output. How the present political unrest will affect conditions is not clear. The author gives much information as to past methods of finance, payment to miners, and prices obtained. He estimates that during the most prosperous period the annual output of copper averaged 5000 tons.

TECHNICAL JOURNALS FOR THE MONTH

BRITISH.

Association of Mining Electrical Engineers, Lancashire Branch.—*November 27:* Experiments with Battery Signalling Bells for Mines, G. M. Harvey, followed by a general discussion.

Colliery Guardian.—*February 4:* Turbo-blowers and Compressors, H. L. Guy and P. L. Jones, paper read before the South Wales Institute of Engineers.

Cornish Institute of Engineers.—*January:* Mine Drainage, Joseph Blight.

The Engineer.—*January 14 and 21:* The Industries of Belgium,* H. Hubert. *January 21 and 28:* Hanyang Iron and Steel Works, China.

Engineering.—*January 14:* Pure Electrolytic Iron and Boron, quoting the University of Illinois Researches, and accounts in the *Zeitschrift für Anorganische Chemie* of German investigations.

Institution of Mechanical Engineers.—*January 21:* Flow of Air through Nozzles, T. B. Morley.

Institution of Mining and Metallurgy.—*January:* Chinese Mining Legislation, W. F. Collins; Taylor's Pulp-Sampler,* W. H. Trewartha-James.

Institution of Petroleum Technologists.—*January 18:* Oil Storage, Herbert Barringer.

Iron and Coal Trades Review.—*January 14:* German Shells, and the Influence of certain Elements on the Physical Properties of Steel, J. E. Stead, paper read before the Cleveland (Yorkshire) Institution of Engineers.

Manchester Geological and Mining Society.—*December 21:* Visual Signalling in Mines, Harold Green, discussing the law that requires signals to remain visible "until complied with." *January 11:* The Value of the Experimental Fan in the Mining Laboratory, D. E. Thomas.

Mining Journal.—*January 8:* Official Assistance to Mining in Burma; Progress of Mining during 1915 in Western Australia and New Zealand. *January 15:* Pulverized Coal versus Crude Oil as Fuel, R. C. Campbell-Johnston [continued *January 22 and February 5*]; Platinum in Sierra de Ronda, south Spain. *January 29:* Tin and Copper during 1915. *February 5:* Review of Spelter and Lead during 1915.

National Association of Colliery Managers, North Staffordshire Branch.—*December 20:* Aerial Ropeway, on Roe System, used for disposal of pit waste at Birchenwood Colliery, J. R. L. Allcott.

North Staffordshire Institute of Mining and Mechanical Engineers.—*January 17:* High-speed Air-compressors for Mining Work, J. M. Walshe.

Royal Institution of Great Britain.—*January 20 and 27 and February 1:* Chemistry and Economics of Coal and its By-products, W. A. Bone.

COLONIAL.

Canadian Mining Institute.—*Bulletin* for *January:* Reviews of Mining Industry by Provinces for 1915 by Gray, Denis, Gibson, and Stirling; Ore Dressing and Metallurgical Laboratories of the Canadian Department of Mines, G. C. MacKenzie: Silver Market Conditions in China, G. G. S. Lindsey.

Canadian Mining Journal.—*January 1:* German Invasion of Belgium with particular Reference to the Mining Industry, A. Ledoux; Coal Trade of Nova Scotia in 1915, F. W. Gray; Mining in Quebec during 1915, Theo. C. Denis; Relation of Governments to Mining, H. V. Winchell, a paper read before International Engineering Congress, San Francisco; Development of Electrolytic Copper Refining, Lawrence Addicks, read before International Engineering Congress, San Francisco; Evaluating Coal Properties in Western Canada, R. W. Coulthard. *January 15:* Mining in Ontario 1915; Coal Mining in British Columbia 1915, E. Jacobs; Alloy Steels, G. L. Norris, read before International Engineering Congress; Mining Cupriferous Pyrite in Quebec, J. A. Bancroft, from report Quebec Department of Colonization, Mines, and Fisheries; Metallurgy of Canadian Cobalt Ores, R. W. Bridges, method used by Canadian Copper Co.; Canadian Supplies of Iron and Steel in Relation to Munitions of War, Thomas Cantley (also in *Bulletin* of the Canadian Mining Institute).

* See Mining Digest.

Chemical, Metallurgical, and Mining Society of South Africa.—*November:* Causes of Accidents in Rand Mines,* C. E. Hutton; Treatment of Antimonial Gold Ores from the Murchison Range, H. R. Adam, discussion; Dust in Mine Air, J. Moir, discussion; Cyanide Consumption on the Rand, H. M. Leslie, discussion.

Mining and Engineering Review (Melbourne).—*December:* North Nuggety Ajax Gold mine, Daylesford, Victoria, James Trevor; Hall Desulphurizing Process, H. F. Wierum.

Queensland Government Mining Journal. — *December:* Oil-Shale Industry, Lionel C. Ball; Copper Deposits of Wide Bay and Burnett Districts, Lionel C. Ball.

South African Mining Journal.—*December 11:* Oliphant's River Mica Belt, W. T. Hallimond; Vereeniging Power Station [continued *December 25*]. *December 18:* The African Tin Industry in 1915; Karroo Coal Prospects, A. L. Chambers. *December 25:* Karroo Coal Prospects, J. E. Mills-Davies. *January 8:* Handling Rock - Drills Underground on the Rand, E. M. Weston.

FOREIGN.

American Institute of Mining Engineers. — *Bulletin for January:* Re-crystallization of Cold-worked Alpha Brass on Annealing, C. H. Matthewson and Arthur Phillips; Underground Mining Methods of Utah Copper Co.*, Thomas S. Carnahan; Broken Hill Mining Methods*, E. J. Horwood; Behaviour of Stibnite in an Oxidizing Roast, H. O. Hofman and John Blatchford; Development of Practical Substitutes for Platinum and its Alloys, with Special Reference to Alloys of Tungsten and Molybdenum*, F. A. Fahrenwald; Control of Petroleum and Natural Gas Wells, A. G. Heggem; Economies in a Small Coal Mine, H. A. Everest; Effect of Aeration and 'Watering Out' on the Sulphur Content of Coke, J. R. Campbell.

Economic Geology.—*November-December:* Pyritic Copper Deposits of Kyshtim, Russia, A. W. Stickney; Copper Deposits in the 'Red Beds' of Texas, L. M. Richard; Effect of Igneous Intrusions on the Accumulation of Oil in the Tampico-Tuxpam Region, Mexico, E. De Golyer; Metal Oxide and Sulphide Impregnation of Fire-brick, N. B. Davis; Relation of Quality of Oil to Deformation, R. H. Johnson.

Engineering and Mining Journal. —*January 1:* The Tom Reed-Gold Road Mining District, Arizona, J. D. Sperr; Coal Tar and its Products; Multiple versus Series Electrolytic Copper Refining, P. L. Gill; Pine Oil for Flotation, C. F. Sherwood. *January 8:* Annual statistical review number with editorial summaries covering production, prices, and metallurgical progress for each of the important metals in 1915 and numerous short supplementary articles by special contributors. *January 15:* Carrie Jane Billings Everson, a historical sketch; Mining in Japan, 1915, H. W. Paul; Flotation Replaces Cyanide, R. W. Smith. *January 22:* A California Dredge with two Tailing Stackers, L. H. Eddy; Bolivian Mining in 1915, P. F. Blick and M. G. F. Söhnlein; Mining in Idaho, R. N. Bell; Mining in Colorado in 1915, G. F. Collins; Design for Mine Car and Rolling Side-Dump Tipple, R F. Smith; The Santa Ysabel Massacre, with sketches of the men killed by the Mexicans on January 10.

Engineering Magazine. — *January:* Handling Materials in Manufacturing Plants, Belt Conveyors, etc., R. L. Streeter, an illustrated article from which hints for an ore house may be derived; Post-Bellum Mineral Production, Arthur Selwyn-Brown, foreseeing great activity immediately following the close of the war.

Far Eastern Review (Shanghai). — *November:* Copper-mining in Yunnan*, V. K. Ting; Mineral Area of Western China, A. J. Moore-Bennett.

Iron Age. —*January 6:* Annual review number with comprehensive and valuable statistical tables covering metal production and prices and reviews of engineering trades in America, and account of the Donora Zinc Smelter.* *January 13:* Stripping Mesabi Deposits.

Journal of the Franklin Institute. — *January:* Recent Progress in the Metallurgy of Copper, H. O. Hofman.

Journal of Geology.—*November-December:* Revision of the Sequence and Structure of the Pre-Keweenawan Formations of the Gogebic Iron Range of Michigan, R. C. Allen and L. P. Barrett; Later Stages of the Evolution of the Igneous Rocks, N. L. Bowen, a 91-page supplement.

Metallurgical and Chemical Engineering.—*January 1:* Thermal Reactions in the Vapour Phase of various Coal Tar Oils and Distillates, W. F. Rittman and Gustav Egloff; Experiments on the Separation of Vanadium from Crude Sodium Uranate, H. H. Barker and Herman Schlundt; Hydrometallurgy of Zinc and Lead in 1915, from Experiment Station University of Utah and United States Bureau of Mines; A Form for Classification of Flotation Data, W. A. Whitaker and George Belchic; Reverberatory Smelting at Consolidated Arizona Smelting Co.; Central Mill of the North Star Mines Co., L. A. Palmer; Mechanical Principles of the Blast-Furnace (also *January 15*), J. E. Johnson, Jr.: Safe Transportation of Explosives and other Dangerous Articles, J. L. Taylor; Barium Industry in the United States since the European War, Maximilian Toch; Radium from Carnotite, details of method of refining used by the United States Bureau of Mines. *January 15:* Carrie Jane Everson and the Flotation Process, H. C. Parmelee, a historical sketch; Grading Industries, E. S. Wiard, a study of sizing operations; Blast-Furnace Smelting of Cyanide Precipitate, Regis Chauvenet.

Mine and Quarry.—*January:* Rapid Sinking at the Newport Mine, J. M. Brown.

Mining and Engineering World.—*December 25:* Development of the Canadian Iron and Steel Industry, Herbert Vanderhoof. *January 1:* Flotation, its Progress and Effect upon Mill Design, C. A. Tupper; Advancement in the Metallurgy of Zinc, M. F. Chase; Editorial Reviews of Mill and Smelter Construction, Dredging, Welfare Work, and other topics for the year 1915. *January 8:* Proceedings of the Second Pan-American Scientific Congress, with brief abstracts of papers dealing with mining; Round Rope on Grooved Drums at Copper Queen Mine, G. F. G. Sherman; Recent Milling Practice in San Juan county, Colorado, Etienne A. Ritter.

Mining and Metallurgical Society of America.—*Bulletin for December:* A detailed report of the meeting held at Washington in the interest of the revision of the mining law.

Mining and Scientific Press.—*January 1:* Testing Ores for the Flotation Process [continued *January 8*], O. C. Ralston and Glenn L. Allen; Drilling in Narrow Stopes; Oatman, Arizona, a Prohibition Camp, Frank H. Probert. *January 8:* Scheelite Mining and Grading, P. B. McDonald; Dredging in Mozambique.

NEW BOOKS AND OTHER PUBLICATIONS

Elements of Mineralogy. By Frank Rutley, revised by H. H. Read. Cloth, small octavo, 400 pages, illustrated. London: Thomas Murby & Co. Price 3s. 6d. net. For sale at the Technical Bookshop of the *The Mining Magazine*.

This new edition is to be heartily welcomed. Three years ago we expostulated with the publishers for re-issuing Rutley's 'Mineralogy' in unrevised form, for the passage of many years had rendered much of the contents valueless and indeed misleading. It had been a wonderful book in its day. It contained more information for its price than any other technical work, and it presented the matter in a perfectly intelligible manner. But being out of date its usefulness had departed, and the appearance of another edition in 1912 was inappropriate. The publishers have recognized this fact, and have now given us a new and thoroughly revised edition. It is admirable in every way, and the greatness of 'Rutley' is restored. Mr. Read has preserved the main design, and has treated the old master with reverential care. The additions and alterations relate chiefly to the modern views of economic mineralogists, and to the uses and occurrences of the various minerals and metals. The method of dealing with the silicates has been altered, the chapter on crystallography has been re-written, and a chapter on optical properties has been added. The glossary of terms and the stratigraphical table are also useful additions. Mr. Read was with the Imperial College before he went to the war, and his many helpers in the production of the book are all South Kensington men. Nor should we forget to mention the introduction written by our good friend George T. Holloway, in which he emphasizes the importance of the business aspect of mineralogy. The price has been raised from 2s. to 3s. 6d., but even with this increase the book is by far the best value at its price. We shall always recommend it to students, and even to those who think they have passed this stage.

Sulphuric Acid and Sulphur Products. By Geoffrey Martin and Major J. Louis Foucar. Cloth, octavo, 80 pages, illustrated. London: Crosby Lockwood & Son. Price 7s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

During recent months we have recorded the publication of a number of manuals of chemical technology issued under the general direction of Dr. Geoffrey Martin. These books, though containing only outlines of the industries grouped round each particular element or chemical substance, are of great value to the chemist or engineer who desires to obtain as large an amount of general information as possible within a short time. At the present time many men are undertaking work for their country in connection with manufactures hitherto unfamiliar to them. And as for sulphuric acid in particular, many mining engineers and metallurgists require information relating to means and methods for preventing the escape of acid fumes into the atmosphere, and for putting them to good commercial use. The bulk of the information in the book is compiled from notes prepared by Major Foucar, who used to be a manager at the Beckton gas works. Unfortunately he has lost his life in the war. A great many detailed additions and corrections are still required, and Dr. Martin will welcome suggestions. We may take the opportunity of saying that the list of roasting furnaces does not include the names best known to the metallurgist. Also, the metallurgist would greatly appreciate a detailed account of the uses of the acid in order to help him to study his possible outlets. Dr. Martin, like most writers, is tantalizingly brief when referring to the applications of sulphuric acid in the arts and manufactures.

Engineering Geology. Second Edition. By Heinrich Ries and Thomas L. Watson. Cloth, octavo, 740 pages, illustrated. New York: John Wiley & Sons; London: Chapman & Hall. Price 17s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

We gave a notice of the first edition of this book in our issue of September 1914. The second edition, now published, contains an additional chapter on 'historical geology.' As we said in our previous notice, the book is of great value to the geologist who intends to follow the civil or mining engineering profession or to the civil engineer who desires to specialize on geological studies. The various chapters deal with: rock-forming minerals; the characteristics of rocks, their mode of occurrence, and origin; structural features and metamorphism of rocks; rock-weathering and soils; surface waters; underground waters; landslides and their effects; wave action and shore currents, and their effect on coasts and harbours; lakes and their origin; glacial deposits; building stone; limes, cements, and plasters; clay and clay products; coal; petroleum, natural gas, and other hydrocarbons; road foundations and road materials; ore deposits; historical geology. The book is devoted entirely to American problems, and the cases cited and the authorities quoted are with few exceptions American. Consequently it forms an appropriate text-book for colleges in the United States, but it is not suitable for use in this country.

Business Prospects Year-book, 1916. By Joseph Davies and C. P. Hailey. Cloth, small octavo, 220 pages. Cardiff: Business Statistics Co., Ltd. London: *The Financial Times*. Price 10s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is the tenth year of issue of a convenient and valuable handbook. The authors discuss what, in their judgment, will happen to coal, iron, copper, tin, tin-plates, oil, the money market, shipping, wheat, cotton, rubber. In general the problem has been construed in terms of the period during the war, immediately at the end of the war, and in the somewhat longer future. It is tacitly assumed that the war will be ended this year or very shortly after. A prolonged contest would obviously change conditions in several instances. The analysis is based upon past and current statistics. The last year for which even approximately complete figures have been collected is 1914. In general the authors see continued or rising prices through the period of the war, a quick hard drop when it ends, followed by a recovery varying in speed and amount for the different commodities considered. The book is most suggestive and interesting. It is well worthy of careful study, and the main points at least of the authors' analyses and conclusions will receive wide acceptance.

California State Mining Bureau. Biennial Report 1913-1914. Advance chapters of the report of the State Mineralogist, F. McN. Hamilton, recently distributed, take the form of convenient hand-books of the mines and mineral resources of the principal mining counties of California. The parts so far issued include Del Norte, Humboldt, and Mendocino counties, by F. L. Lowell; Shasta, Siskiyou, and Trinity, by G. Chester Brown; Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, and Stanislaus, by W. C. Bradley, G. C. Brown, F. L. Lowell, and R. P. McLaughlin; Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, and Yolo, by W. W. Bradley; and Amador, Calaveras, and Tuolumne, by W. B. Tucker. In each case a brief general geological description is followed by tables of output and notes on each mine or group of claims giving the essential facts as to situation, ore, and equipment. The books form invaluable reference texts to all who have dealings with California mines. It is understood that similar handbooks covering the remaining counties are in preparation.

The Copper Deposits of Eastern Quebec. By J. Austen Bancroft. Paper covers, octavo, 300 pages, with maps and illustrations; published by the Government of the Province of Quebec. Cupriferous pyrite has been mined in Sherbrooke county, near Memphremagog lake, for many decades and the region enjoyed a boom forty years ago, but only two or three mines are now active. The ore is found in association with highly altered igneous rocks. The present report is the result of an examination that was made with the object of ascertaining whether many of the properties could be re-opened if a custom smelter and a chemical works were provided. The geology and the various mines and properties are described in detail.

The Canada Year-book 1914. Cloth, octavo, 700 pages, with map and illustrations. This book is published by the Canadian Ministry of Trade and Commerce. The contents include a history of Canada's development and of its constitution and government, information relating to the geographical features, the geology in relation to agriculture, and the flora and fauna. The bulk of the book, however, consists of statistics relating to population, finance, outputs of grain, fish, timber, and minerals, railways, canals, telegraphs, telephones, and postal service, etc. Like all official Canadian publications, this does credit to the compilers.

YEARLY REPORTS OF MINING COMPANIES

Falcon Mines.—This company was formed in 1910 under the auspices of the Gold Fields Rhodesian Development Co., to work a gold-copper deposit 60 miles east of Gwelo, Rhodesia. The report for the year ended June 30, now issued, shows that smelting operations commenced in June 1914, and that to the end of the financial year under review, 130,567 tons of sulphide ore was treated for a yield of 2621¾ tons of blister copper, containing 2574 tons of copper, 31,461 oz. gold, and 53,303 oz. silver. The income from the sale of copper was £186,893, of the gold £134,557, and of the silver £5506, being a total of £326,957, or 50s. 1d. per ton of ore treated. The working cost was £255,782 or 39s. 2d. per ton, leaving a working profit of £71,174 or 10s. 11d. per ton. Out of this profit £28,160 has been paid as interest on debentures and loan, and £30,000 has been placed to the fund for the redemption of debentures. The issued capital of the company is £400,000, and there are £250,000 debentures and a loan, with interest accrued, of £244,603. During the year development on the 7th level added 196,943 tons to the reserve, the total of which stood on June 30 last at 696,236 tons of sulphide ore and 177,793 tons of oxidized ore. The sinking of the main shaft was resumed, and preparations were made to open 8th and 9th levels. It is expected that the shaft will cut the lode at 872 ft. At 722 ft. an orebody put in appearance, and the question to be solved is whether it is a new one or a faulted part of that which is being worked. Unfortunately the new lode is of low grade. Details of the concentration and smelting plants extracted from H. A. Piper's report are given elsewhere in this issue.

Nigerian Tin Corporation.—This company was formed in 1909, Oliver Wethered being chairman, with the object of prospecting for tin properties in Nigeria and investing in the shares of operating companies. Properties were acquired in the Naraguta, Zaria, Kano, and Ninkada districts. The report now issued covers two years ended June 30 last. During this period 267 tons of tin concentrate was produced, selling for £18,997, and the amounts show a loss of £4917. The corporation has investments in other companies, with a book value of £67,556; these have yielded dividends to the corporation of £1315.

De Lamar.—This company was formed in 1891 to acquire from Henry Bratnober the gold-silver mine previously worked by J. R. de Lamar in Owyhee county, Idaho. For five years the mine did well and paid good dividends. In 1901 the main orebodies were exhausted, so the capital was reduced, and work was continued on a smaller scale, with fairly satisfactory results. In 1913 the mine was finally exhausted, and attention was turned to the Afterthought property on the south side of De Lamar mountain. A mill was erected, and should have started in July last. But it was not ready until the approach of winter, so E. V. Orford, the manager, suggested that the start should be delayed until the coming spring. Owing to the slender financial resources of the company, the directors have decided to sell the property, and negotiations to that end are now proceeding.

Mexico Mines of El Oro. — This company was formed in 1904 by the Exploration Company to acquire a mine at El Oro, Mexico, from the Mexican Gold & Silver Recovery Co., the latter company being the organization formed to work the MacArthur-Forrest patents in Mexico. In 1910 the control passed from the Exploration Co. to the French and Pearson interests, and though the company is still an English one the head office is in Paris. The mine is on the same lode, the San Rafael, as the El Oro and the Esperanza. The report for the year ended June 30 last shows that the mine was in operation for only five months, from October to February, owing to the unsettled conditions. During this time 33,210 tons of ore was raised from the Mexico mine and 1470 tons from the Nolan, and 30,825 tons was sent to the mill, where bullion worth £84,650 was extracted. The net profit was £15,597, which was carried forward. The ore reserve is estimated at £505,300 tons, averaging 10 dwt. gold and 6·4 oz. silver. Eighteen months ago the contract was signed for the purchase of the Nolan property for 30,000 shares, but owing to the delay in receiving necessary documents from Mexico, these shares have not yet been issued. In our issue of May last year we published an article by the manager, Fergus L. Allan, describing the orebodies at this mine.

Mount Lyell Mining & Railway.—This company was formed in Melbourne in 1893, as a reconstruction of a former company, for the purpose of developing a copper deposit near Mount Lyell on the western side of Tasmania. Smelting commenced in 1896 under the direction of Robert C. Sticht, and the pyritic method of smelting developed has become classical practice. In 1903, the property adjoining belonging to the North Mount Lyell company was acquired, by an amalgamation of the two companies. By this amalgamation the two companies were both well served, for the pyritic ore low in copper of the Mount Lyell and the silicious ore higher in copper of the North Mount Lyell formed an ideal smelting mixture. The report of the company for the half-year ended September 30 last shows that at the Mount Lyell mine, 116,296 tons of ore was raised, 102,550 tons coming from the lower workings and 13,746 tons from the open-cut. Of this amount, 109,090 tons, averaging 0·47% copper, 1·5 oz. silver, and 0·8 dwt. gold, was sent to the smelter, and 7206 tons was sent to the chemical works for superphosphate manufacture. At the North Mount Lyell, 65,831 tons of ore was raised averaging 6·32% copper, 1·2 oz. silver, and 0·1 dwt. gold. At the smelter, 109,543 tons of Mount Lyell ore, 66,742 tons of North Mount Lyell ore, 83 tons of Lyell Comstock ore, and 97 tons of purchased ore was treated, yielding 4053 tons of blister copper, containing 4009 tons of copper, 219,804 oz. silver, and 5018 oz. gold. Developments at depth during the half-year have given highly satisfactory results at both mines. The reserves on September 30 were estimated as follows: Mount Lyell, 1,791,479 tons averaging 0·53% copper, 1·96 oz. silver, and 0·548 dwt. gold; North Mount Lyell, 973,210 tons averaging 6% copper, 1·33 oz. silver, and 0·1 dwt. gold. These figures do not include any ore developed during the half-year. The flotation plant is in course of erection, and should start work shortly. The accounts of the company show that 1294 tons of copper carried over from the previous half-year has been sold at an average price of £86. 8s. 1d. per ton, and that of the production of the half-year under review 2072 tons was sold at an average price of £87. 13s. 10d. The net profit for the half-year was £139,071, as compared with £98,220 for the previous half-year.

Mouramba Copper Mines. — This company was formed in 1910 to acquire copper mines, formerly the property of the Nymagee Copper Co., Ltd, situated in the Cobar district of New South Wales. The Nymagee company was floated in this country in 1906, but the operations were suspended the year following. The report now issued covers the year ended June 30 last and shows that the company was marking time owing to adverse metal conditions. Since the period covered by the report smelting has been re-commenced, and matte containing 633 tons of copper has been produced from 19,255 tons of ore, being an extraction of 3·28%. A second blast-furnace is to be blown-in shortly. E. J. Rodda has recently been appointed manager, and he reports that developments are giving encouraging results.

Broken Hill Block 14.—On the outbreak of war the mining of sulphides was suspended, as the Junction North company which purchased and concentrated the ore was unable to continue the sale of its lead and zinc concentrates. The mining of carbonate ore from the upper levels was however continued. The report for the half-year ended September 30 shows that 4339 tons of carbonate ore was raised and sold, as compared with 4608 tons during the previous half-year. The average assay of the ore was 27% lead and 14½ oz. silver per ton. The ore sold for £17,369, and a profit of £4358 was made. As regards dividends the 100,000 preference shares of 6s. each received interest at £1500, and the 100,000 ordinary shares of £1. 5s. each and the 100,000 preference shares receive 6d. per share or £5000.

Broken Hill Block 10.—This company is still unable to find a market for its lead concentrate and zinc tailing. Before the war the lead concentrate was sold to Germany and the zinc tailing to the Amalgamated Zinc (De Bavay's). It has not yet been possible to dispose of any of the lead concentrate in Australia. O. B. Ward, the manager, has spent most of his time on Misima island, near Papua, superintending work on a gold mine on which the company has an option.

Associated Northern Blocks.—This company was formed in 1899 to acquire the Iron Duke leases at Kalgoorlie, Western Australia. For eight years handsome dividends were paid. On the approaching exhaustion of the mine, four years ago, the Victorious property at Ora Banda, 35 miles north of Kalgoorlie, was acquired. The reserve of oxidized ore at the Victorious was found to be less than expected, and the plant had soon to be re-modelled to treat sulphide ore. The new mill started in December 1914. The report for the year ended September 30 shows that from the re-start until the latter date, 14,248 tons of oxidized ore and 18,002 tons of sulphide ore was treated for a yield of gold worth £45,347. The working cost was £31,344, and £8403, spent on plant and development, was charged to capital account. At the Iron Duke, tributers' ore yielded £10,641, of which the company received £2056 as royalty, and the re-treatment of 93,001 tons of sand tailing by the tributers yielded £15,317, of which £1016 accrued to the company. The accounts for the year showed a profit of £10,193, the whole of which has been written off for the cost of development, diamond drilling, and depreciation. The development by mining and prospecting by drill have not disclosed any additional ore high enough in gold to be worth working, and the reserve is estimated at 14,000 tons. Additional claims adjoining the Victorious have recently been acquired. C. O. G. Larcombe has made a geological examination, and he considers that development at depth is warranted.

Tongkah Harbour Tin Dredging.—This company was formed nine years ago, under Tasmanian laws and under Australian control, for the purpose of dredging tin-gravel on the shore at Tongkah island, off the coast of the Western Siamese States. It will be remembered that in 1910 we recorded the quarrels between experts as to the value of this dredging ground. In spite of adverse opinions expressed by several engineers, the venture has been highly profitable so far. The report for the year ended September 30 last shows that 2,968,600 cu. yd. of gravel was dredged for a yield of 1262 tons of tin concentrate, as compared with 2,199,408 yd. and 1126 tons the previous year. The yield per yard was 0·95 lb. as compared with 1·14 lb. The concentrate sold for £123,260, being at the average price of £97. 12s. per ton. The dredging cost was £55,208, administration expenses £7821, allowance for depreciation £14,817, and payment to the Siamese Government £3500. The shareholders received £22,500, being at the rate of 15%, and £17,300 was carried forward. During the year four dredges were at work for about 70% of the time. It has not been possible to recover No. 1 dredge, which was sunk about two years ago. No. 6 dredge started work in January 1915. The ground worked has been variable in content, and at many places the yield was poor. Eliot T. Lewis is manager.

125

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

EDGAR RICKARD, *Managing Director*. H. FOSTER BAIN, *Editor*. EDWARD WALKER, *Assistant Editor*

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CONTENTS.

REVIEW · OF · MINING

Introduction. — Cornwall is again the centre of interest for the moment, two of the famous old mines, Dolcoath and East Pool, having just held annual meetings of which we speak elsewhere. The success at the East Pool in developing at moderate depth an important new lode, hereafter to be known as the Rogers, is turning development in a direction likely to prove more fruitful. There are many areas in which the copper veins were worked down through the slates to the granite, but where there was little or no exploration below. There are also large blocks of ground in and between known tin-bearing lodes that have never been cross-cut. As there has been heavy local buying of East Pool shares, the people of Cornwall are evidently disposed to back their own mines. One most excellent suggestion made by Mr. C. A. Moreing, in his speech to fellow shareholders at East Pool, was for a central mining board. We believe the time is ripe for this, and the good such a board could accomplish is too well understood to need argument. At the back of the picture is the rising shadow of a possible nationalization of the mines of Cornwall, a matter that is being quietly but generally discussed. Many of the properties are already under Government control as an incident to stimulation of wolfram production. The extension of the system to complete nationalization may come faster than any of us now anticipates.

Away from Cornwall there is everywhere the steady demand for metal and, subject only to limitations of smelting and refining facilities, the mines around the world are working at maximum capacity to meet the demand.

Transvaal. — The output of gold on the Rand during February was 727,346 oz., and in outside districts 26,248 oz., making a total of 753,594 oz., worth £3,201,063, as compared with 759,852 oz., 27,615 oz., 787,467 oz., and £3,344,948 for January. The number of natives employed at the gold mines at the end of February was 209,426, as compared with 209,835 at the end of January, and 180,422 a year ago.

The succeeding quarterly reports of the Government Gold Mining Areas (Modderfontein) show improving results of development. During the quarter ended December 31, 4150 ft. sampled gave 3370 ft. of profitable ore averaging 12·8 dwt. over 50 in. The number of stamps is being increased from 100 to 200 and of tube mills from 10 to 20. The additional plant is now in course of erection. When completed the total capacity will be 100,000 tons per month. The Consolidated Gold Fields has purchased a block of the shares in this company. The efforts of the controllers to modify the terms of the lease under which the property is held from the Government have been of no avail, and the Minister of Mines has stated incidentally that the Government has no intention of conducting mining operations in the Far East Rand on its own account.

The development of the Booysens area recently acquired by the Robinson Deep is to be commenced forthwith, and the site of the vertical shaft has been selected. This shaft will be rectangular with seven compartments, and is estimated to cut the reef at a depth of 4500 ft.

The Consolidated Mines Selection Company reports a large balance to the credit of profit and loss for the year 1915, due largely to the continued improvements at Brakpan and Springs as regards both present profits and excellent development results. The available balance at the end of the year was £93,000 compared with £34,250 at the end of 1914. A dividend is recommended at the rate of 15%, as against 5% for 1914 and 1913. The company's financial position is strong, as was shown by its success in engineering the Daggafontein deal.

The continual fall in the shares of the East Rand Proprietary has been an unsatisfactory feature of the market lately. Last month we noted that the quotation had sunk to nearly par; since then it has gone to 17s. A year ago the price was 29s., and five years ago £5. The figures for February showed that gold worth £199,537 was obtained from 168,500 tons of ore milled, being an extraction of 23s. 8d. per ton, and that the working profit was £38,301, or 4s. 6d. per ton. During the year 1914, the yield per ton was 27s. 4d., the working profit 8s. per ton, and the distribution to shareholders at the rate of 4s. 8d. per ton. It will be seen that the difference between working profit and distributable profit was 3s. 4d. A study of these figures indicates that with a working profit of 4s. 6d. per ton, as in January, there will be little available for division among shareholders.

Rhodesia.—The yield of gold during January was worth £318,586, as compared with £331,376 in December and £293,133 a year ago. Declines were registered at Eldorado, Golden Kopje, Shamva, and Giant.

West Africa.—The output of gold during January was worth £140,579, as compared with £158,323 in December and £143,649 during January a year ago. The December returns were unduly inflated owing to part of the Abbontiakoon yield for November being included in them. The figures for Prestea Block A show an increase from £39,161 in November to £37,247 in December and £40,123 in January.

At the Ashanti Goldfields, the Obuasi shoot is now being developed on the 16th level. Where the cross-cut reached the lode, the latter has been proved to be 12 ft. wide, assaying 13 dwt. per ton. The cable message does not indicate the position of the cross-cut in relation to the shoot, so that comparison cannot yet be made with the levels above. The average assay of the reserve in the Obuasi shoot is well over an ounce per ton.

Australasia.—The latest law is that all companies registered in Australia must get rid of alien shareholders within the next three months. All who are not actually British born will be considered alien. Of course this is directed against Germans, but unless some modification is made, it will also hit the French, Italians, Swedes, Americans, and others. The market will be swamped with these shares, and prices will fall unless the companies buy in the shares themselves. The Government will have to fix a market rate. Local papers say that, to be consistent, the Federal Government must extend this law to land, buildings, and all property. The proceeds of the shares are to be placed in the hands of the Comptroller of Customs, who will be instructed later how to dispose of them.

The Great Boulder Proprietary recently took an option on the Magdala mine at Stawell, Victoria. Owing to the poor results obtained by the boring operations from the 1300 and 1400-ft. levels the company contemplated abandoning the option. The owners however, approached the Minister of Mines with a view of obtaining State aid in order to continue exploration work. The Minister agreed to contribute £600, provided the owners subscribed a similar sum, for the purpose of unwatering the mine between the 1400 and 1600-ft. levels. The Great Boulder Company has agreed to spend £500 in additional exploration, after the unwatering has been completed.

The Mines Department of West Australia has favourably considered an application for financial assistance to sink a new shaft at the Great Fingall, and has agreed to advance a sum of £15,000 toward the cost of the work. The new deep orebody in the property is worked from an internal shaft 2000 ft. north of the main shaft at the No. 17 level, but finding that double haulage combined with double trucking made costs prohibitive, the manager recommended the sinking of a new main shaft 2000 ft. to the north of the present one, and on his advice the mill was closed. It will be remembered that Dr. Malcolm Maclaren made an exhaustive geological examination and report on this mine, which showed that the marked increase in the value of the ore disclosed at the No. 18 level north was a most hopeful indication of a general improvement in depth. Nothing like it had been discovered in corresponding positions from the thirteenth to the seventeenth levels.

The Corinthian North mine near Bullfinch has had its first clean-up after a full month's run with the sulphide plant, the return being £3561 from 3227 tons. Costs are not reported, but the recovery is stated to be much better than was ever obtained from the treatment of the oxidized ores. A duplex Edwards roasting furnace with a capacity of 65 tons per day has been erected for the treatment of the sulphide ore.

Details of the woodcutters' strike at Kalgoorlie and its results are given by our West Australian correspondent. The official report of gold output for February reflects the effect of the stoppage of the mines on the gold production throughout the state, the figures being £288,717, as compared with £399,220 for January.

At the Mount Lyell, full-scale trials of the flotation plant have been made, with excellent results. The amount of ore treated per day was 80 tons averaging 5·13% copper. The concentrate averaged 13·9% copper, and the tailing 0·47%, indicating a recovery of 94%.

Burma.—The markets have shown considerable interest in Burma Corporation shares lately, and we are glad to present a careful account of the Bawdwin mines prepared at our request by Mr. J. D. Hoffmann. Mr. A. F. Kuehn has not yet returned from the property, but a new ore estimate may evidently be expected soon, as development has now been carried down to the Tiger Tunnel level. Any one who has watched the cable reports needs no assurance that the estimate will be favourable.

Cornwall.—At the meeting of shareholders in the Dolcoath Mine Limited, the manager, Mr. R. Arthur Thomas, described the plan for further development. Exploration at depth has, for the time at least, been abandoned, and attention is to be paid to the western part of the property between the 490 and 440 fathom levels. When the Williams vertical shaft was sunk this work was included in the proposals for development, but opportunity or necessity has only arisen lately. The ground to be prospected lies on a parallel lode to the west of the main lode between the Wheal Harriet and Stray Park shafts. The former has recently been sunk to the 490 fm. level, and connection made with the workings from the vertical shaft. The ventilation is thus greatly improved, and the atmosphere made bearable. Seeing that the water at this depth has a temperature of 110° F. the need for ventilation is obvious. The 490 fm. level is being continued toward the Stray Park shaft, and the 440 fm. level above is to be driven in the same direction. It is intended to spend £13,000 in exploration, and if the first results offer the requisite encouragement, a more extensive scale of development will be adopted, bringing the expenditure to £35,000 or £40,000. The new owners of the royalties have signified their readiness to reduce the dues, in order that more of the company's revenue shall be devoted to exploratory work.

East Pool is one of the few companies that keeps up the good old Cornish custom of a shareholders' dinner following the annual meeting, and whether it was fame of the dinner or rumours of good news that attracted the sixty or more shareholders and guests who sat down together on March 8, there was no disappointment on either score. The four great roasts were carved with skill and generosity, and the 'trimmings' were quite all that they should be. Among the fortunate guests we enjoyed the spectacle, and did not observe that any neglected the opportunity of sharing in the visible evidence of company prosperity, despite their keen interest in the speeches from the head of the board. The chairman, Mr. H. Montagu Rogers, spoke with wise conservatism regarding the new orebody of which our correspondent from Cornwall has already written, and yet made it clear that the policy of exploration to the north had been amply justified, and that the long lean days had come to an end. As our readers know, a new vein, subsequently named the Rogers at the instance of Mr. C. A. Moreing, has been penetrated on the 160, 212, and 240-fathom levels, and explored sufficiently to demonstrate that a large body of ore, coarser in grain, and much richer in content than those worked at lower levels, has been opened. To the district as a whole the event is important as demonstrating the value in depth of the old copper veins where they pass out of the slate into the granite. There are many other points where similar exploration may be expected to yield equally good results. Mr. Moreing, speaking for the managers, pointed out that the work of the year had been accomplished despite a loss of

46% of the employees, who had gone to the war. He also put in a plea for closer co-operation among the Cornish mining companies, even to the extent of the forming of a general mining board to handle matters relating to drainage, exploration, and improvement of treatment. His remarks evidently produced an impression among the many leading mining men of Cornwall who were present.

South Crofty still enjoys the distinction of being the only dividend payer among the Cornish mines. During 1915 the ore treated amounted to 70,790 tons, and the yield of tin, wolfram, arsenic, and other products realized £92,000. After full allowance for development and depreciation, a profit of £5672 remained, out of which £5000 was distributed as dividend, being at the rate of 10%. The new lode at the adjoining East Pool is of considerable interest to South Crofty, for its western continuation may be expected to pass through Crofty ground.

Canada.—The rapid increase in gold production in Ontario and the problem of taxation of mines is discussed elsewhere by Mr. F. H. Hamilton. There is undoubtedly a better feeling about Ontario mines now that the Hollinger has shown that workable bodies of ore persist in depth, and the Dome has been rejuvenated by the discovery of what is virtually a new orebody lying to the south-west and at lower levels than that which gave name and fame to the property.

In our January number we quoted the *Canadian Mining Journal* as estimating Canadian gold production for 1915 at $8,000,000. We should, of course, have credited this figure to Ontario. The total for Canada was £3,883,000, as we indicated last month. The output seems certain to increase despite the disappointment involved in several short lived surface shows, but the rate of increase will depend upon many factors.

United States.—Metal prices and metal production are at record heights in America and the constant marvel is the absorptive capacity of the market. Not only the major but the minor metals have been affected. Quicksilver, for example, has risen from the low price of $40 per flask before the war to $300 per flask at present. California, more particularly the Coast Range contiguous to San Francisco, is the principal source of cinnabar in the United States, although Nevada also produces some. As pointed out in the *Mining and Scientific Press* by W. H. Landers, resident manager for the New Almaden company in Santa Clara county, the method of treating cinnabar ore to produce mercury has undergone practically no change since 1871, when the Scott furnace was developed. While the process is simple in theory, consisting merely of distilling the metal while reducing the sulphide, the mechanical difficulties are great. The mercury vapour is extremely penetrating and will diffuse itself through bricks and concrete, where the mercury condenses. Likewise the liquid metal itself when collected in the bottom of the condensers is, on account of its high specific gravity, forever seeking a crevice in which to hide, so that it will penetrate apparently solid masonry that easily retains water.

Figures quoted by *The Mining Magazine* from the speech of Mr. John Ballot at the shareholders' meeting of Minerals Separation are held in the United States to be conservative. It is pointed out that two companies alone, namely, the Anaconda and Inspiration, licensees of Minerals Separation, are treating 14,000 tons per day. That means 10,000,000 tons per annum. This is only a small part of the tonnage being treated in Western America, in which as a whole 60,000 tons per day is now being subjected to flotation, and about half of it in plants under license to Minerals Separation. In addition there is Canada, where the Britannia is treating 4000 tons daily, Chile, where the Braden treats 3500 tons daily, and Australia. In the annual report of the Anaconda, it is stated by Mr. John D. Ryan, the president, that 20,000 tons of copper has been added to the annual production without either increased cost or increased tonnage from the mines. The additional profit nearly equals the price paid by the Anaconda for the Corocoro copper mines.

Alaska.—As has been frequently rumoured, the Treadwell companies operating on Douglas Island near Juneau are soon to be consolidated into one. The three have always been under a single management and the majority of the shares in each is owned by the same group, so that the change will be more one of form than fact. We understand that the reserve funds of the companies involved and the credit of the consolidated properties will be sufficient to carry through the deal without public financing and also to provide for the new work contemplated. The valuation of the mines is to be made this summer by a committee consisting of F. W. Bradley, H. C. Perkins, and Hennen Jennings. It is intended to develop the Alaska-Mexican shaft, which is well situated for such use, into a central deep shaft equipped for mining to 5000 ft. The present central shaft is only designed for operations to 3000 ft. It is also probable, though the matter is still undecided, that a new central mill will supersede the individual units now employed.

Experiments being made at the Alaska Juneau mine, which is under related management across Gastineau Channel, with ball mills show distinct promise, and it is possible that a ball-mill practice growing out of that developed at the Inspiration copper mine in Arizona will, in time, take the place of the historic stamp-mill work that has produced so much gold at Juneau. We discuss elsewhere the relations of the various great gold mining companies operating near Juneau.

Mails from the interior of Alaska are subject to much delay, and we only recently received a letter written early in October giving details of the season's work near the headwaters of the Kuskokwim. The season there turned out well. Canyon creek yielded over 40 lb. of gold dust to one party, and Bear, Julian, New York, and other creeks gave good returns. George J. Shoup, of San Francisco, who owns gold-antimony veins between the headwaters of Kwishik and Togiak rivers, is arranging for extensive development work this season. An Idaho prospector reports a high-grade copper lode, but in general attention has been too closely centred upon placers for lodes to receive much notice.

Russia.—The improvements in practice at the Lena Goldfields, introduced by Mr. C. W. Purington, have already given remarkable results. The figures of production for the year 1914–15, just published, show that 902,459 cubic yards of gravel was treated, for a yield worth £1,782,886, as compared with 843,259 yd. and £1,277,069 during the previous year. The yield per yard thus increased from 30s. 4d. to 39s. 6d. This improved extraction is due to the substitution of long sluices of the Alaska type in place of the trommel machines and kulibinas. The new method also has the advantage of being cheaper. Another economy introduced on Mr. Purington's recommendation is in connection with the recovery of the timber used in the drifts. The operating company has not yet issued a statement of costs, so that the decrease in the cost cannot yet be gauged.

Notable Deaths.—C. W. Hayes, who died at Washington early in January, was one of the best known, generally respected, and widely liked of the present generation of American geologists. Graduating from Johns Hopkins University, he joined the staff of the United States Geological Survey, rising to the position of chief geologist, a place that he filled with distinguished success. He also served his government in the early exploration of Alaska, in examining the route of the proposed Nicaragua Canal, in studying Cuba, and in combating the slides at Panama. He resigned to become vice president in charge of production for Lord Cowdray's oil companies in Mexico, staying until Americans were withdrawn from that country. At the time of his death he was acting in a consulting capacity to the Pearson oil interests.—John A. Hill, publisher of the *Engineering and Mining Journal*, *Coal Age*, and other periodicals, was a forceful American who rose from the ranks to a prominent position by virtue of his ability and energy, and the opportunities of his country. He was an important factor in placing technical journalism in the United States upon a high plane and a solid business basis.—John Wesley Judd, Emeritus Professor of Geology in the Royal School of Mines, died on March 3, at the age of 76. After completing his student days at the School in 1863, he was for a short time engaged in iron and steel analysis at Sheffield, but four years later he joined the Geological Survey. From 1876 to 1905 he held the position of Professor of Geology at South Kensington.

EDITORIAL

AS one result of the restriction upon imports we shall be obliged to print *The Mining Magazine* upon unbleached paper for a few months at least. We feel sure that our readers will join us in regarding this as only a minor sacrifice of convenience and appearance, in the face of the heavy sacrifices made by our friends at the front.

WRITING from the front, Captain L. G. Hutchinson, of one of the mining companies, adds to thanks for comforts sent to his men by our readers, "When we've finished our little recruiting job for the Kaiser's Flying Corps, we'll come and help you make the old world rich again." There will be none more welcome than the miners among those who return from the front.

GEO-CHEMISTRY is a subject where one deals with so many unknown conditions that it is especially important to have the facts in the case well sifted. We note with pleasure that appreciation of the work of Mr. F. W. Clarke, of the United States Geological Survey, in patiently collecting and weighing the data of geo-chemistry, has proved so widespread as to necessitate a third edition of his valuable book.

LITIGATION over the Globe & Phoenix still drags its way through the courts. Mr. A. H. Ackermann recently left the witness box after answering more than 8000 formal questions, and the end is not yet. The suggestion was made that an expert should be sent by the Court to examine and report upon points where the testimony is conflicting, but the Court decided against this, because in addition to the expense and delay, there would still be conflict of testimony. One of the difficulties arises from the fact that not all witnesses were allowed to see all parts of the mine, the Court having refused an order to permit the plaintiff's experts such entrance. The case is at least serving one good purpose, in that it warns against the seriousness of apex litigation.

DIAMOND markets have been unexpectedly good for the last few months, and not only has diamond washing been resumed in the Transvaal, but the Union Government contemplates permitting an output of 10,000 carats per month from the mines of South-West Africa. Small stones of industrial sizes have sold at rising prices in London lately, despite the stringent regulations on shipment through the country. A more interesting development is the increased demand for gem stones which is noticeable in Germany and Belgium as well as in America and the Allied Countries. In part this is the expression of the fact that the munitions and other war industries have made new millionaires. In part though, especially we believe in Belgium and Germany, people are buying diamonds as a convenient method of hoarding wealth. Paper money is losing its attractions, and gold is to be held by the Government so that people fall back into the primitive condition where they treasure precious stones. We learn that there are several thousand diamond cutters working in Antwerp.

MEMBERS of the Association of Old Students of the Royal School of Mines held their annual meeting at the Mining and Metallurgical Club on March 14. Formal dinners have been postponed until after the war. The elder members of a profession that has so liberally responded to the country's call are not desirous of indulging in official merry-makings while their younger brethren are valiantly risking life and limb on the battlefield. The Association announces that the 'History of the Royal School of Mines' is now complete, and will be issued after the war. This has been prepared by Miss Reeks, the daughter of Mr. Trenham Reeks, who was Registrar from 1851 to 1879. Efforts are also being made to expand and revise the Register of Old Students that was published in 1896, and the assistance of individual old students is invited by Mr. S. J. Speak, 5 London Wall Buildings, E.C., the President of the Association, and Mr. E. B. Lichtenberg, 3 and 4 Great Winchester Street, E.C., the Secretary.

THE Annual General Meeting of the Institute of Metals is to be held on March 29 at the lecture hall of the Chemical Society, Piccadilly. Seven papers are to be presented, of which that by Dr. Alfred Stansfield on electric furnaces applied to non-ferrous metallurgy will prove of chief interest to our own particular circle of readers. Methods of preventing corrosion will be discussed at the meeting, and other items on the agenda relate to tin-aluminium-copper alloys, the analysis of aluminium, the annealing of nickel-silver, and transformations in alloys of gold and copper. The May lecture is to be delivered on May 4 by Professor W. H. Bragg, his subject being 'X-rays and Crystal Structure, with special reference to certain Metals.' The President-Elect of the Institute is Dr. G. T. Beilby, who is known to us for his work in connection with metallic sodium and sodium cyanide.

DINNERS have a usefulness in addition to serving their physiological purpose. Their social value is not to be overlooked. The annual dinner of the Institution of Mining and Metallurgy held on February 24, while informal in character and less well attended than in previous years, was nevertheless a significant affair. It was good to hear from Sir Richard Redmayne, the incoming president, that the miners are doing their full share in the work of the war. With 20 per cent of the men from the pits in England volunteering, and with approximately one-third of the members of the Institution itself in service, the record is one of which we may all feel proud. Major Godfrey Morgans, Sir Robert Hadfield, Sir Alfred Keogh, and Mr. Beeby Thompson supplied interesting details and sent us all away inspired and encouraged, while Sir T. Kirke Rose presided with grace and dignity, and with a spirit of fellowship which made each member present feel that this was in fact as well as name a family gathering. In these trying days, and even when a great battle hangs in the balance at the front, it is well to have such gatherings. The war task still before the Allies is a heavy one, and it will not be soon accomplished. Every force the nations have must be organized for maximum usefulness, and ties already strong must be strengthened. Mining men are demonstrating that it is possible to take an active part in the war, and at the same time to keep up the regular work of the profession. What, possibly, is not so well understood is that maintaining the output of the metals, improving processes, finding new supplies and new uses, cheapening production, and training men, are not only patriotic duties of the present, but vital to national success in the long years of industrial conflict that will follow the last battle. Mining men must learn to work together even better than in the past, and their agencies, such as the Institution, must be strengthened and made more useful, not only because our business affects the bread and butter supply of our own families, but because the business is essential to national success and prosperity. A dinner that unites men for such a task is worth while, and it was with such a dinner that the Institution closed its year's work.

Speculation in Metals.

Metal dealers in London were taken by surprise at the beginning of March, when regulations were issued under the Defence of the Realm Act prohibiting speculative dealings in the principal metals. The purpose of such regulations is, of course, to lower prices. The immediate effect, especially in the iron market, was in this direction. What the final result will be is less certain. On the one hand it may be urged that as, in the case of copper and zinc in particular, the bulk of the supplies originate outside the Empire, the price is fixed by those who are not subject to the regulations. There is merit in this contention, though it must not be forgotten that the immediate market for metals is now largely influenced by shipping conditions. There is no such shortage of lead in the allied and neutral countries as of spelter, and yet the London price has risen and probably will go still higher, because of the difficulty of getting lead to London. This difficulty will probably become greater rather than less as the months go by. The spelter situation has been frequently discussed, and in essence the high prices reflect scarcity of metal. It would seem that there should be no corresponding scarcity of copper with all the mines working at full capacity and Germany eliminated from the buying, and yet prices have gone higher and higher. A real scarcity does in fact exist. In part this is directly due to munitions manufacture, and in part to the great increase in industry in America. Though figures of home consumption are no longer printed in the United States, it is only necessary to watch the figures for steel and the trade reports to realize that local consumption is on an enormous scale. The American copper producers are working very closely together. They have shown ability to control the output, and they would not be forcing it unless there was a strong demand for copper now, and also an anticipation of similar demand for the next three months at least. In the United States, sales of metal are mainly from producers direct to consumers and not, as in the United Kingdom, through metal houses. The largest producers sell, on long time contracts as they produce, and there is not the opportunity for speculation in metals by outsiders that the British system has permitted. Whether in the long run the effect of speculation is to stabilize prices or to accentuate the peaks is still a matter for dispute. It is well known that the bear interest, buying to cover, sustains a falling market; but it is also true that the interest of the broker is in moving prices. Whether they go up or down is a secondary matter so long as sales are made and commissions earned. Under the new regulations no one may sell or offer to sell the principal metals unless the metal be in his possession or in the course of production for him, nor may anyone buy or offer to buy, save for or on behalf of a consumer. Presumably the word 'consumer' here means someone who has a definite use for the metal. This will work considerable changes in the trade, as large amounts of metal are regularly carried in London by brokers acting for themselves or others. There is also little direct contact between producers and users, but presumably the work of the big houses which assemble and distribute metals to regular customers will continue undisturbed. However widely the terms of the order may be interpreted, the effect will undoubtedly be to restrict trading; indeed for a few days it nearly stopped and no quotations were recorded. It will be interesting to see the ultimate effect on prices of this new Government regulation.

Labour Problems in Zinc Smelting.

Smelting zinc ores involves certain processes not common in metallurgy and these in turn introduce difficulties as regards labour. Experienced operators see in this the main reason why British zinc smelters are now working at less than full capacity while Australian zinc mines stand idle and the Imperial authorities pay fabulous prices for foreign spelter. The larger part of the world's output of zinc now comes from sulphide ores, and in their treatment they undergo two processes: roasting, with acid-making as a by-process, and distilling. The roasting and acid-making introduce no complications not met in ordinary metallurgy, though the temperature regulation is naturally different in treating blende from that required when roasting pyrite. There are all over the United Kingdom, as well as in nearly every other country, numerous plants where sulphides are roasted and acid is manufactured. There is no reason to suppose that, so far as this part of the process is concerned, the establishment of British works would give rise to new problems of any especial difficulty. We have seen roasting and acid-making conducted skilfully and economically by gangs of black men having only limited supervision by skilled whites, and we have also seen it conducted by smaller forces of picked, trained, and highly paid white employees. Surely somewhere between these extremes there is opportunity to recruit a force in any civilized country.

The distilling of the metal from the roasted ore is another matter. This difficulty arises from the fact that the process is conducted in a number of small units and is not continuous. Each day's work stands by itself for, by a fortunate combination of circumstances, it takes just 24 hours to treat a charge of zinc ore, to empty, and to refill the retorts. For most of the time during the 24 hours there is relatively little to do. It is a matter of carefully regulating the temperature, and of drawing and casting the metal as made. Once each day the furnace is partly cooled, the retorts opened, the residue raked out, a new charge of ore and coal inserted, the condensers luted into place, and the temperature of the furnace again raised. All this is hard work, and the charging requires many hands who are employed for only a few hours, for the furnace must not be allowed to cool unduly. The firing of the furnace and the drawing of the metal require a small number of men. Formerly they worked 24 hours at a time, so that each furnace crew saw one charge through the whole process. The reason lies in the fact that one of the big expenses of zinc smelting is that of broken or burned retorts. So long as there is metal in a retort it is not apt to burn through, but when the last of the zinc is distilled over, the retort may be ruined quickly unless the furnace is cooled. Indeed the cooling must begin before the last of the zinc is distilled or breakage will be severe. Also the quality of the metal depends to a considerable extent upon the temperature at which it is driven over, because this controls the amount and character of the metals other than zinc which find their way into the slabs of spelter. In order to recover the last of the metal in the retorts the heat must be raised above that of the earlier hours of the run and yet, as already noted, this involves grave risk of retort breakage. Clearly, the men who run the furnace need to know in great detail how it has been driven from the beginning of the run, in order to complete the work economically. For this reason the 24-hour shift was established, with the correlative of a short shift for the men who do the charging. With the introduction of gas firing, the building of longer furnaces, and the perfecting of drawing cars and charging machines, the labour situation has been changed materially. Mixing the charge is now usually done by machine, and the various furnaces are so driven that the old charging crew has given place to men who work shifts of normal length. Indeed, there are furnaces where the whole work has been re-organized on an eight-hour basis, though it is still more usual for one or two men on each furnace to direct operations for 24 hours at a time. The number of men who work these long hours has steadily decreased, and their technical skill has become higher. There is an increasing tendency to depend upon recording instruments for temperature records and upon written data at other points, and less upon the old-time skill and memory. This dignifying of the work of the old captain into true technical direction has been accompanied step by step by a decreasing call for skill on the part of the ordinary furnace workmen. While charging machines are as yet mainly useful as a protection against possible strikes, other mechanical devices have been so perfected that little skill is required on the part of the ordinary members of the crew. A new organization of labour is therefore possible. This involves a limited number of skilled long-shift men engaged in real technical work, and a large number of unskilled men working normal hours. In the United States there are no longer enough Spaniards, Belgians, and native Americans skilled in the work to man the furnaces on the old basis. The result is that the best of the old men, supplemented by young men from the technical schools who expect to be metallurgists rather than workmen, direct the furnaces. The rough labour is accomplished, with the help of various mechanical devices, by raw immigrants fresh from the farms and small villages of the Balkan States, of Poland, or of South Russia. This has required structural changes in the furnaces, which are built longer and lower than in former years, as well as in organization. These unskilled workmen are not able to charge the retorts of the upper row of the old furnaces as did their predecessors. We understand that Welsh smelters encounter similar difficulties from the fact of the taller and stronger workmen having emigrated. It is to be expected that satisfactory methods of charging the retorts mechanically will be perfected in time, and interesting experimental work directed to this end is in hand. In the meantime we would suggest that the difficulty of long hours in zinc smelting and the need of skilled men, looms rather larger in the public estimation than facts warrant. To establish in Great Britain a large zinc-smelting industry would, it is true, require material re-organization of the labour, but in a country where in a few months immense munition plants and many other complex and highly technical works have been built and set going, we do not believe that this is beyond the power of accomplishment.

The Rand as a Fossil Placer.

If the social features at the end of the year were dimmed by war, the technical interest of the February meeting of the Institution of Mining and Metallurgy by no means shared in the depression. Three papers of much interest were presented relating respectively to the antimony production in Hunan, the first bucket dredge in Northern Nigeria, and the conglomerates of the Rand. The last mentioned was an elaborate and able exposition by Dr. E. T. Mellor of the conclusion that he has reached, as a result of his survey of the fields for the Transvaal government, that the Rand bankets are fossil placers. This, of course, is not a new theory. It is one which has been advanced before and ably defended, by Messrs. G. F. Becker and J. W. Gregory among others. It is but fair to say, however, that the general trend of opinion of recent years has been toward regarding the Rand deposits as lodes, though admittedly of somewhat unusual character. This theory has been especially well stated and urged with great ability by Messrs. F. H. Hatch and C. B. Horwood among recent writers. We have already printed, in our issues of November and December last, much of the stratigraphical evidence upon which Dr. Mellor rests the conclusions he now announces. On another page we present a brief abstract of the points made by him in the particular paper under review. The text itself should be read in full to appreciate the force of his argument and the nature and amount of evidence with which he backs it. Those of us who have had no personal experience on the Rand may well be modest in venturing judgment where many able men with first-hand knowledge of the facts differ so markedly in interpretation. There are certain significant matters, however, that we may be permitted to discuss.

It may be noted in the first place that no man, probably, has as extensive a knowledge of the Rand bankets as Dr. Mellor. The fact that the Transvaal Survey was far too poor to give him an adequate staff proves to have been a blessing in disguise. He has studied the Rand from end to end, personally investigating outcrops, bore-holes, and mine sections. It is a laborious and a slow method, but, for one that does not get lost in detail, a sure one. Furthermore such bias as he had at the beginning was against the theory he now espouses; he was converted by first-hand observation of the facts in the field. It is true that Dr. Mellor is a geologist and not a miner, and there are those who seem to believe that unless a man handles a muck-stick, his opinion as to an ore-deposit is valueless—he is a 'theorist,' not a 'practical man.' This is a singular mental attitude, since one would seem warranted ordinarily in believing that, as to a geological problem, the conclusions of an honest and trained geologist who had studied the field are as worthy of belief, let us say, as those of a physician who diagnoses a fever. Both make mistakes, but the most practical of men turn to the physician when puzzled by the antics of his liver or other internal organs. Dr. Mellor has treated the Rand as one big geological problem and his conclusions will at once make wide appeal to geologists familiar with similar problems. That he differs from others who have recently written on the subject must be imputed mainly to the difference in the facts available to him. Most men have written of the Rand after experience principally with the Central Rand and with it in view. Probably it is true, as Dr. Mellor suggests, that if mining had begun on the Far East Rand the balance of belief would now be different. The great horizontal sheet of conglomerate found there, with gold distributed in patches exactly where sedimentation would make its occurrence most probable, is different in many important particulars from the steep dipping, irregularly enriched, reefs of the Central Rand. The bankets of the Central Rand show more of the characteristics that link them with lodes and less of those that indicate placers, than do those of the great East Rand basin. The reverse is also true. We are all influenced, unconsciously let us hope, by our pre-judgments. Most mining engineers who work with gold deposits have more knowledge of lodes and of igneous rocks and of igneous processes than they have of beds and of sedimentary rocks and of sedimentary processes. There are many good reasons for this. One of the results is that mining engineers seldom know much about sedimentation and of what sedimentary processes are capable. In point of fact there is no inherent presumption against the Rand gold being of placer origin. The great goldfields of the world have been and are today placers, and there is no more stretching of theory to make the Rand bankets fossil placers than to make them lodes. If they are peculiar placers they are even more peculiar lodes. If the secondary introduction of pyrite proves them infiltration deposits, it proves the same for the ancient channels of California, the Deep Leads of Australia, and the Vitim placers of Siberia. If the recrystallization of the gold argues them lodes, then most quartzites—and many limestones and dolomites—are equally the resultant of igneous forces. If each of the arguments advanced in favour of the lode theory be similarly examined, it will be found to lose much of its force. The matter is perhaps not finally settled. We have often remarked that in theoretical discussions of such matters opinion swings from extreme to extreme, but, just as in another journal in summing up the discussion of Mr. C. B. Horwood's articles in favour of the lode theory we asked for suspended judgment, we may urge the desirability of a thorough and candid examination of the evidence in rebuttal that Dr. Mellor has submitted. Even if final judgment should prove unfavourable, which we do not anticipate, Dr. Mellor's work will stand as a worthy example of patient and thorough research directed to both scientific and practical ends.

The Juneau Mines.

Confusion regarding the identity and relations of the great gold mines at Juneau, Alaska, is persistent. Even that usually well informed paper, *The Financial News*, announced recently that the Alaska Treadwell would shortly spend $4,000,000 upon the Alaska Juneau property. We can assure our contemporary that the Alaska Treadwell has no such intention, though, as we note in our review columns this month, other interesting plans are incubating as regards that famous gold producer. To help set matters straight we reproduce below a small sketch map which shows the geographical relations of the various properties. It will be noted there are two great gold-bearing belts. One is on Douglas island across the channel from Juneau, the other is on the mainland, back of that city. The Douglas island mines constitute the Treadwell group, long well and favourably known in London. It was this group in which the Exploration Company purchased an interest on the advice of Hamilton Smith, and of which H. C. Perkins, Thomas Mein, and F. W. Bradley have successively been consulting engineers. There are three companies, the Alaska Treadwell, Alaska Mexican, and Alaska United. All work on the same lode and mine parts of the same ore-shoot, the Alaska United having, in the '700-foot claim,' a block of the main ore-shoot between the Treadwell and the Mexican.

THE MINES NEAR JUNEAU, ALASKA.

The Treadwell group is on Douglas Island, and the Alaska Juneau, Perseverance, and Ebner are on the mainland.

The Alaska United also owns the Ready Bullion mine on an independent ore-shoot south of the Mexican mine, and so is represented on the map in this position. Ownership of the Treadwell mines is rather more widely scattered than is customary with American gold mines. In addition to the British shareholders there are important holdings in France and minor ones in various other European countries. Control rests with the Americans, being in the hands of a group of Californians represented by Mr. F. W. Bradley, the president, and various ex-Californians, among whom perhaps Mr. Ogden Mills has the largest holdings. The Treadwell companies were pioneers in wholesale mining of low-grade gold ores, and have established records for low cost not yet equalled outside Alaska on any large scale. While there are three separate companies, the majority of the shares are owned by much the same people, and the three have always been managed by one staff. The achievements of the Treadwell managers constitute one of the brilliant chapters of successful gold mining.

Running from Sheep creek north through Silver Bow basin, back of Juneau, is a second great lode. It is different in character, the gold being found in quartz stringers in a black slate belt instead of in a meta-diorite as on Douglas island, but it is similar in being extensive and of low grade. There are also three companies operating or preparing to operate here on a large scale. These are not, however, affiliated. They represent different financial groups, and their methods of operation are not the same. To the south is the Perseverance mine. This was at one time the property of the Alaska Perseverance company and was introduced to British investors by the late not altogether lamented Colonel W. J. Sutherland. Pearse, Kingston & Browne were at one time consulting engineers, but the financial part of the enterprise did not keep pace with the technical direction, with the result that the company came to grief. It was succeeded by the Alaska Gastineau, which is today the operating company. Through Mr. B. L. Thane, and with the help of Mr. W. P. Hammon, various interests were consolidated, and in 1912 control was purchased by the late A. F. Holden and Mr. D. C. Jackling. The Alaska Gold Mines was organized as a holding company, and with Hayden, Stone & Co. handling the finances, while Mr. Jackling looked after the technology, the property started on its career as a large-scale producer of low-grade ore. This company has attracted much attention in the United States but is, as yet, little known in London.

North of the Perseverance mine is the Alaska Juneau. This mine attracted the attention of Thomas Mein while he was serving as consulting engineer for the Treadwell companies, and he secured control for himself and Wernher, Beit & Company. It produced gold at remarkably low cost, though working upon a small scale, and meanwhile Mr. Mein and his successor Mr. Bradley studied its possibilities as a large scale producer. When the business of Wernher, Beit & Company was dissolved, the interest held by that firm passed to Mr. Mills, Mr. Bradley, and others of the California group active in direction of the Treadwell mines. In 1912 a small syndicate among them undertook to furnish the money necessary to open the property on a large scale. The underground developments proving good, and the preliminary metallurgical studies giving promising results, a part of the shares was released to the public in New York just about a year ago. It was the sale of these shares that provided the $4,000,000 now being spent upon further development and equipment under the direction of Mr. J. H. Mackenzie as managing director and Mr. Philip R. Bradley as superintendent.

Beyond the Alaska Juneau is the Ebner which covers the northern extension of the great lode. This property has been badly involved financially, but the United States Smelting Refining & Mining Company, of which Mr. Sidney Jennings is managing director, has taken it in hand and is studying the problem of bringing it also into production on a large scale. These six companies, all either actually producing on a large scale or definitely on the way toward such production, will certainly play an important part in sustaining the American output of gold. Whether near Juneau still other mines of comparable size remain to be opened cannot yet be positively stated, though serious prospecting is being undertaken at a number of points. It would be well, however, for mining engineers and financial writers to get the six mentioned firmly fixed in mind. One minor cause for confusion in London is the quotation of the shares of the Alaska Goldfields, Limited, among the mines. As the chairman of the company has pointed out, Alaska Goldfields is not a mining company, though originally formed to finance the purchase of placer mines in the Klondike region. Shares in the Northern Commercial Company and Northern Navigation Company were all that was ever actually purchased, so that the company derives its revenue from trading, not mining.

Camp Bird Going Deeper.

An interesting change in plan of work at the Camp Bird mine in Colorado has been announced, as one result of the recent visit of Mr. J. A. Agnew. It will be recalled that the adit through which the main workings have their outlet was driven about at the contact, here essentially horizontal, between the San Juan tuffs below and the overlying Silverton series of rhyolites. The main bonanza orebodies of the San Juan district have been found in the Silverton series and, while there is not so great difference in the two formations on the whole as the contrasted names imply, the San Juan rocks are certainly tougher and less 'kindly' than the Silverton. It was doubtless this consideration which entered largely into the decision, made some half-dozen years ago, to explore horizontally at or near the adit level rather than to undertake deep development, in this following the advice of Mr. J. E. Spurr who studied the property for the company. When the mine was examined for purchase by Camp Bird Limited, rich bodies of ore had been traversed horizontally at the adit level, but their extension above and below was not known. There was much discussion among the examining engineers as to whether the ore-shoots were properly to be regarded as elliptical orebodies having their major axes horizontal or vertical, a most important matter in fixing a safe price for the property. We believe the general consensus of opinion favoured regarding the horizontal extension the greater one. Subsequent work has tended to show that the vertical factor was more important than then estimated. Inspection of stope maps now shows ore - shoots with the major extension downward, as is normal for orebodies in such rocks. Several such bodies have been followed below the adit level well down in the San Juan tuffs. Work on one was stopped by a heavy flow of water, but at the No. 3 shaft an ore-shoot, barely 20 ft. long when first found but lengthening to 250 ft. below, has been followed nearly 1000 ft. below the adit. These lower orebodies in the San Juan are not so rich as were those worked in the Silverton series, but they have yielded a substantial profit despite the high cost of work through internal shafts. It has now been decided that, having plant and staff available, there is too much ore in sight and indicated below the adit, to warrant abandoning the property without thorough development. A new adit is to be driven from the mill level to drain and prospect the vein at 400 ft. below the lowest workings. The work will require two years time, and will cost approximately £40,000, the distance being some 10,000 ft. The adit will not only open lower ground in the Camp Bird vein, but will also permit the prospecting of numerous promising leads in the intervening territory. Even this new adit will not exhaust the possibilities of the property. If driven at the horizon of the mill, it will be (we speak from memory), at least 500 ft. above the base of the San Juan series and the highest of the sediments, the Telluride conglomerate. It will be remembered that there have been a number of excellent and highly profitable mines worked at horizons still lower. Writing in 1902, Mr. C. W. Purington expressed the opinion that the Camp Bird would prove profitable to a total depth of at least 2000 ft., which would bring the workings to the base of the volcanic rocks. With the experience of other mines in the region in mind, we may at least hope that ore will extend still further. We doubt if the geologists have got at the bottom of matters in the San Juan any more than the miners have bottomed their lodes. The Camp Bird has proved one of those rare mines which has been continuously disappointing—but always on the right side.

THE BAWDWIN MINES

By J. D. HOFFMANN.

Studies of Chinese records showed that for many years large supplies of silver flowed from the south to the capital. War stopped the mining and the very site of the mines was forgotten. A few years since rich lead slags were found in the bush in the Northern Shan States. A railway was built, smelters erected, and industry revived. Old mines were found and intelligent direction of exploratory work has now developed orebodies which afford the basis for an enterprise likely to develop into the largest lead-silver-zinc producer in the world.

FEW of the orebodies opened in recent years have attracted more attention in the mining profession than those now being developed by the Burma Mines, Limited, at Bawdwin; and not without good reason. Mining here certainly began as early as the 15th century, and an enormous amount of metal has since been taken out, an amount that it is impossible to estimate with any degree of accuracy. In the brief period since the resumption of mining under European control, the total income from the sale of products has been approximately £1,000,000. This, with a like amount of new capital, has been spent in construction, working costs, and development. During 1916 it is expected that all operating and construction costs can be paid out of current profits from a small operating unit, part of which was originally designed for testing only. While much has been written about the Bawdwin mines, it will perhaps prove serviceable to have a general summary of their history and of the present status of the enterprise. At the request of the editor, I am, therefore, glad to furnish this.

The Bawdwin mines are in the Northern Shan States of Burma, within about 50 miles of the Chinese border. They are connected with the Burma Government railways by means of a 50-mile 24-in. gauge line, built by the mining company, from the mines to Manpwi on the Mandalay - Lashio line. Manpwi is 169 miles from Mandalay, and 554 miles by rail from deep water at Rangoon. The branch railway owned by the mining company traverses a heavily wooded mountainous country with deep-cut ravines and soft treacherous banks that have made both construction and maintenance expensive. I may anticipate by saying that it was built as cheaply as possible to afford transportation for a definite amount of rich slag left by the old Chinese miners, and which formed the basis of the first resumption of smelting. It was adequate for the purpose, but in order to make it serve the larger needs of the present, it has been necessary to repair large portions of the line. Recently it was shortened five miles and a new junction made with the Burma railways at Nam Yao. Doubtless if the present situation could have been anticipated and the possibility of using the road as part of a trunk line to China properly appreciated, a different sort of a railway would have been built. It is well to remember though that it is a very different matter to prepare for transporting 115,000 tons of slag, the amount estimated by Mr. C. S. Herzig as contained in the dumps—a forecast which, it may be stated, proved excellent though slightly conservative—and to prepare for a great mining enterprise lasting through a period of years. It is worth bringing out these facts, since much of the discouraging delay of early years was due to defects in the transportation, and a glance through the photograph books of the old company might mislead one into thinking that the locomotives spent most of their time rolling down embankments.

HISTORY.—The early history of the mines is obscure. The best general statement was compiled with much labour by Dr. Malcolm Maclaren in 1913. As it has not been published, I shall make liberal extracts from the manuscript. According to Maclaren, from the 5th to the 13th centuries the vicinity of the mines was probably in the hands of the Shans. Early records mention in detail the finding of gold in the 7th and 8th centuries, but no mention is ever made of silver. This omission would strongly indicate that the Shans, who were never real miners, did not work the Bawdwin mines. Following the Mongol invasions information is lacking as to the country taken and retained by the Chinese, but it is probable that Bawdwin was not occupied by them until the invasion of 1343 A.D. The Chinese, according to one inscription, started work at Bawdwin during the Ming dynasty in 1412. No doubt the Shan power terminated about this date, and the Chinese invasions of 1582 A.D. deferred their getting another footing. It may be inferred that the mines were worked exclusively by the Chinese from the

Clearing for Smelter.
VIEW LOOKING NORTHWEST FROM SUPERINTENDENT'S

15th century on. Recent Chinese records show that the Bawdwin mines were worked from 1796 to 1851. During this period the mines were within what was nominally Shan territory and the Chinese paid a very small royalty to the King of Burma. The mines appear to have been governed by a president (Ta-Yeh) and a vice president (Erh-Yeh) elected by the miners.

The first European to mention the mines was Michael Symes in 1795. He stated that they were at Badowem, six days journey from Bamoo (Bhamo). In 1827 Crawford, who came into contact with Chinese traders from Bawdwin, estimated the production of silver at £120,000 per annum and the royalty paid to the King of Ava was £600. He was told that 1000 men were working. In 1855, it is said only 40 ticals of silver (£5) were paid to the King of Ava, although Dr. Oldham was told that 10,000 Chinese were working at Bawdwin. The apparent discrepancies between the number of men at work and the royalty paid is not thought to mean a decreased output at the mines, but to indicate the waning of the power of the Burmese kings to collect their royalties. Dr. Oldham further states that about this time the output of the mines was 2130 oz. silver per day derived from ore assaying 163 oz. of silver per ton. No doubt these figures are exaggerations, but may be accepted as showing that operations at the mine were at least active in 1855. Mr. Taw Lein Ko, the government archæologist of Burma, estimates that the Chinese community contained fully 20,000 people. To the west, northwest, and north, old fortifications may be seen covering a distance of 12 to 14 miles. At the site of the village the main stone-paved road and the ruins of numerous dwellings and temples still remain in the valleys and on the hills. The stream was kept under control by well built retaining walls. Three stone bridges are still intact. Many graves are scattered over the hillsides.

In 1855, the Panthay (Chinese Mahommedan) rebellion started, and devastated the country until 1873. The Panthays, with their success and skill in mining, aroused the jealousy of the Taouists, and minor conflicts gradually grew into a huge struggle throughout the whole of Yunnan. In 1873 the rebellion came to an end by the capture of Tali-fu and the treacherous massacre of 30,000 Mahom-

Pang Sang Village.
BUNGALOW, NAMTU, BEFORE THE SMELTER WAS BUILT.

medans. It is estimated that from three to four millions of people, including women and children, had perished, and Yunnan was left devastated and in no condition to continue mining. During the confusion the Kachins preyed upon the community at Bawdwin, cutting off the incoming supplies of charcoal and fuel wherever possible. This seems to have determined the final retreat of the Chinese. When the abandonment of the mines did take place in 1868, it is said to have been so precipitate that 78 mule-loads of silver were hidden and abandoned and have not yet been found. No doubt the departure of the Chinese put an end to successful and continuous mining operations until the advent of the first English company formed in 1902. In the meantime, the Burmese Kings, Mindoon Min and Thibaw, sent "armies" to work the mines, but owing to epidemics and a lack of mining and metallurgical skill, the work was soon abandoned.

After this early period of which Maclaren has written, nothing of importance occurred until January 1901 when Aviet T. Sarkies, a merchant of Rangoon, was induced to visit Bawdwin by a Burmese who roused his interest by a wonderful tale of the riches of the mines in silver, lead, and zinc, and the piles of slag running high in lead. The first move was to have the property examined by W. A. Freymuth, who represented Messrs. Sulman & Picard. The report set forth that a smelter and a narrow-gauge railway were warranted. Other reports were made by Messrs. F. D. Chase and C. S. Herzig, and subsequently the Burma Mines, Railway & Smelting Co., Ltd., was formed in March 1906. In May 1908, the name of the company was changed to Burma Mines, Limited.

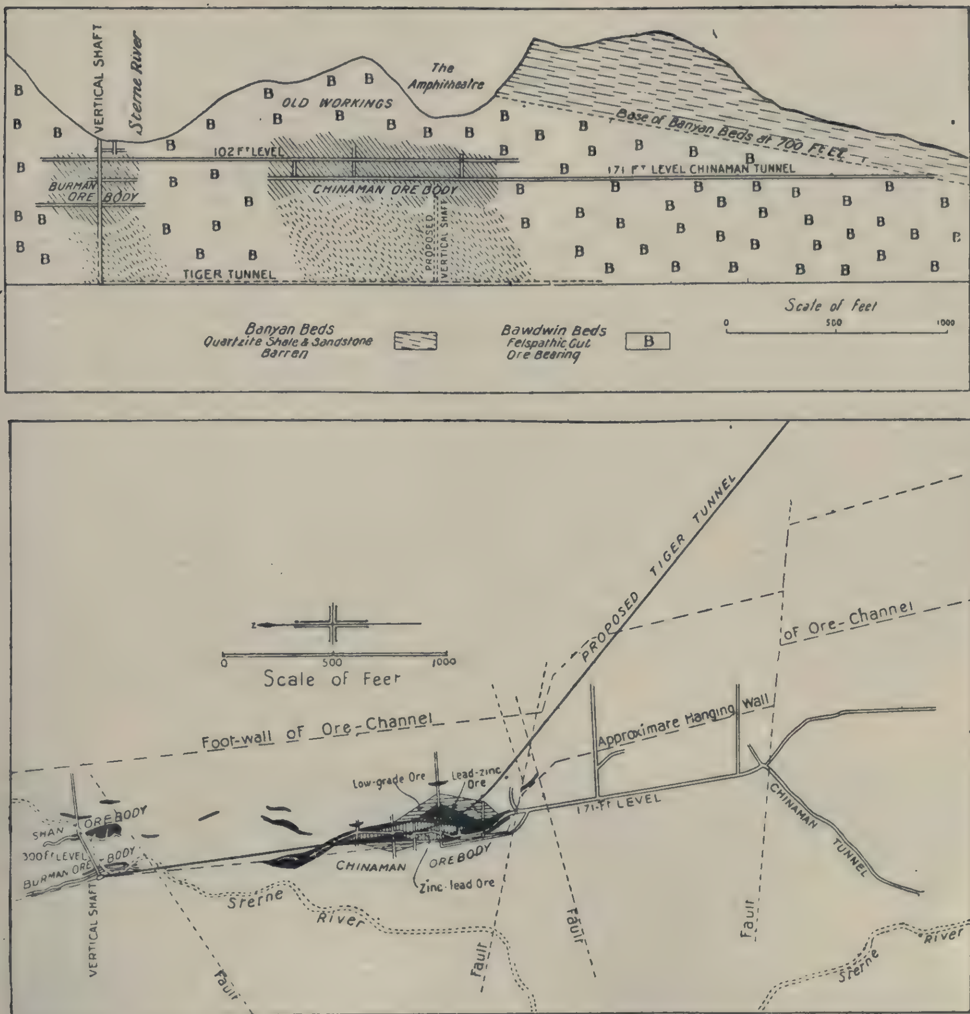
In December 1908, the railway was completed from Tiger Camp to Manpwi. The next year the line was completed to the mine. A smelter was erected at Mandalay and the first furnace was blown in during February 1909. After two years of smelting, the smelter was removed to Namtu, a point only 12 miles from the mine. Since that date smelting operations have been carried on continuously, the production of lead being about 1000 tons, and of silver in lead bullion 22,000 oz., per month. The present rate of production is somewhat higher, and is being increased. The total production since the starting of the smelter in 1909 to the end of October 1915, has been 66,000 tons of lead and 1,432,000 oz. of silver, which was derived from 158,000 tons of old slag and 35,000 tons of ore, and on which over £1,000,000 has been realized. During the whole period of slag smelting operations, the engineers were curious as to the source of the ores from which the slags were derived, and the possibility of developing a valuable mine in the neighbourhood of the old Chinese workings at Bawdwin was of course in mind as more and more capital was put into the enterprise. Only desultory prospecting was carried on in the old caved workings until 1911, when active mining operations began. From the start, although this work was attended with unusual difficulties, the results have been uniformly successful. It was in 1913 that the great Chinaman orebody, which constitutes the present chief feature of interest, was penetrated.

GEOLOGY.—The geology* of the Northern Shan States has been described recently in some detail by Sir Thomas Holland and G. H. Tipper in a bulletin on 'Indian Geological Terminology,' issued by the Indian Geological Survey. A brief abstract, with a small geological map, appeared in *The Mining Magazine* for August 1914. The oldest rocks in the region are certain granites, gneisses, and schists occurring in the northwest. On them rest Cambrian beds consisting of the mica schists of Mong Long, above which is the Chaungmagyi series of unfossiliferous red, purple, and grey quartzites, slaty shales, and felspathic grits. These rocks are in turn covered in the neighbourhood of the mine by the Bawdwin volcanic series of grits, tuffs, and rhyolites. The older sediments, and presumably the volcanic series, were deformed and eroded before being covered by Ordovician sediments. Erosion has since exposed the whole series. The rocks near the mine have been discussed further by T. D. La Touche and J. C. Brown,† who point out the dominant structural feature of the region, a great overthrust fault which has been traced about 30 miles. Bawdwin is near its northern limit and where a minor line of disturbance branches off from it. The orebodies are thought to have structural and genetic relations to this zone of faulting.

Our principal source of information regarding the geology of the mine itself and immediate surroundings is an unpublished report by Dr. Malcolm Maclaren and the semi-monthly summaries of observations by Mr. M. H. Loveman, the geologist for the company. No complete detailed topographic and geologic map has yet been made. Maclaren recognized an upper and a lower sedimentary series and one of igneous rocks. The upper or 'Banyan' series of beds, consists of quartzites, sandstones, and shales. These rest unconformably upon the lower rocks, have been largely cut away by erosion, and have no relation to the orebodies. The lower sedimentary series, the Bawdwin beds, consist of felspathic grit, and were considered by him to be the ore-bearing beds. Below are the tuffs and lava flows of the rhyolitic series. The rhyolites and associated tuffs were found exposed in a belt of country about one-half mile wide and extending in a northwest-southeast direction. The southwest boundary of the rhyolite was thought to have been determined by a fault plane for the greater part of its course. The rocks near the mine were mainly tuffs and breccias, but to the northwest true flow structure showed. The Bawdwin beds were described as being homogeneous grey felspathic grits becoming coarser grained in places until they present a brecciated appearance. It was suggested that in part they might be ash beds. The ores known at the time of Maclaren's study were in these beds. It was held that the rhyolites were the oldest rocks locally present, and that they were covered unconformably by the two closely related sedimentary series of which the basal one was pyroclastic. The faulting took place prior to ore deposition, the planes affording the channels through which the ore-depositing solutions found their way into the easily replaced grits. Two major nearly parallel faults about 500 ft. apart were recognized, with several cross faults. The orebodies were held to have been formed through replacement in that part of the formation best suited to this action. Prospecting to the north was discouraged, since in that direction the more massive rhyolite replaced the grits, but it was Maclaren apparently who pointed out that the structure favoured the finding of ore under the overlying cap of sediments to the south, where in fact, the big Chinaman orebody, which was indicated by a large open cut on the surface, has since been found. He also pointed out the limits of the zone within which prospecting has since proved so profitable, and he indicated that the ore would probably be found to continue in depth so long as the shear zone continued in the felspathic grit.

*In the following account of the geological conditions I am indebted to H. Foster Bain for segregating the important facts from the available information.

†*Engineering & Mining Journal*, Sept. 18, 1909.



Vertical Section and Plan of Mines, at beginning of 1914.

Mr. M. H. Loveman, who has served as geologist to the company since December 1914, has confirmed fully Maclaren's main conclusions, though he has modified them in certain significant particulars. In general his work has emphasized the close relations of the felspathic grit and the rhyolite. In the lower levels the fresher rock shows that the ore is in true rhyolite, a conclusion which Maclaren accepts, and in the upper levels the felspathic grit is held to be, in part at least, merely altered rhyolite. Mapping the rhyolite in detail has shown the area of outcrop to be irregular and the boundaries to be determined not by a faulting contact, but by the change from altered to unaltered rhyolite. There is then still to be solved here the same problem of relative importance of true igneous rocks and of pyroclastics in a great volcanic series that has led to controversy at Tonopah in Nevada, at Waihi, and in other districts. So far the bottom of the rhyolite flow has not been found, and the question suggests itself whether intrusive rocks as well as inflowing waters, by any chance, enter into the problem. The matter is not of immediate economic importance, since the amount of ore already found is more than ample for many years of working. By the time it does become important the geologists will doubtless have worked out the problem. For the present it is sufficient to say that the orebody occurs in an ancient volcanic series, in part under a sedimentary capping, and that it was formed through replacement, presumably by ascending deep seated waters near the locus of important fault planes, where a coarse tuff afforded a particularly favourable habitat. There is, according to both Maclaren and Loveman, no evidence of secondary enrichment in the orebodies now opened up.

DEVELOPMENT.—When it was decided to attempt re-opening the mines, the first work consisted of cleaning out some of the old Chinese adits and workings. It was soon recognized that several orebodies existed which came to be known as the Shan, Burman, and Chinaman lodes, but their relative sizes and richness were not then known. It was decided to prove the Shan and Burman lodes by means of a vertical shaft and to open up the Chinaman orebody through the already existing 'Dead Chinaman' tunnel and also by means of an incline shaft.

By the end of 1913 the vertical shaft had reached a depth of 339 ft. The Burman lode had been opened up at the 102, 171, and 300-ft. levels, and the Shan lode at the 50, 102, and 300-ft. levels. Other smaller lodes, the Dormouse, Palanung, Kachin, etc., were found. All of this work, as well as that during the first few months of 1914, showed that this part of the ore channel was greatly disturbed, the orebodies being erratic and faulted. The Burman lode varies in width from 1·6 to 4·7 ft., and contains lead-zinc ores of varying value. The Shan lode is narrow on the 102-ft. level, and also contains lead-zinc ore; on the 171-ft. level it pinches to almost nothing; on the 300-ft. level it opens into a large body of copper ore; and on the 430-ft. level lead-zinc ore again predominates. A considerable quantity of good ore will be won from this part of the mine, but the tonnages and value cannot be intelligently estimated as yet, and have therefore not been included in the recent ore reserve estimates, which refer entirely to the Chinaman orebody.

While this work was proceeding from the vertical shaft, the opening of the Chinaman lode was also under way, although, prior to 1913, very little was accomplished. The Chinaman tunnel had been driven to the point of entering the southern extremity of the orebody. A cross-cut from the incline shaft penetrated only a low-grade unimportant orebody. Later developments have proved that the main lode had been cut off by a fault before reach-

A HEAVY FILL ON THE RAILWAY, ILLUSTRATING THE CHARACTER OF THE COUNTRY AND THE CONSTRUCTION.

SINTERING PLANT. TILTING THE SINTERED MATERIAL OUT OF THE POTS.

ing a point as far south as the incline shaft workings.

During 1913, the Chinaman tunnel (the No. 2 or 171-ft. level) was driven about 1000 ft. within the orebody, and cross-cuts were put out at eight different points. The lode was shown to average 55 ft. in width with a maximum width of 113 ft. and the value of the ore was found to be excellent. The No. 1 (102 ft.) level penetrated the north end of the orebody for a distance of 150 ft. This work was sufficient to indicate the great possibilities and importance of the Chinaman orebody, and a more systematic and extensive schedule of development was laid out. More capital was required for such an undertaking, and in October 1913 the Burma Corporation Ltd. was formed, and bought a controlling interest in Burma Mines Ltd. That corporation also became the general managers of the property, succeeding Bewick, Moreing & Co., who remained as consulting engineers. Later the Corporation acquired additional holdings until now it owns a majority of the debentures and over 99% of the shares of Burma Mines, Limited.

To explore the lode below the Chinaman Tunnel, an internal shaft was started from this level at co-ordinate 1510 ft. south, and also a winze at 1135 ft. south. A favourable tunnel site was found in the Sterne River valley convenient to the railway, and nearer to the smelter, which would permit of an adit being run to cut the orebody at a depth of about 660 ft. below the collar of the vertical shaft, and such an adit, the Tiger Tunnel, was started. This tunnel, which will reach the ore channel at about 6000 ft. in, will then be turned to follow the strike of the lode. It will serve to drain the mine and to be the main haulageway for the ore. Having in view the heavy rains in this, a tropical country, the Tiger Tunnel is important not only because it affords drainage and transportation in an ordinary sense, but also because it obviates the necessity of keeping up a long expensive surface line. The internal shaft has attained a depth 500 ft., 19 ft. below the Tiger Tunnel level, and has been stopped pending a connection being made with the Tiger Tunnel. Levels Nos. 3 (300 ft.), 4 (430 ft.), 5 (540 ft.), 6 (653 ft.) were started from this shaft. Winze 1135 ft. south was stopped at a depth of 301 ft. as considerable water was encountered. Levels Nos. 3 and 4 were also started from the winze. Drifts have been put out to the north and south from both winze and shaft and also a number of cross-cuts to the limits of the orebody. Due to sinking and pumping operations requiring the greater part of the cross-section of the shaft and of the hoisting capacity, the development of these levels is proceeding at a moderate rate, and to date none of them is complete. Levels 5 and 6 are hardly more than started.

The most striking features of the development below the No. 2 (171 ft.) level are the almost entire absence of old Chinese workings, and the finding of large quantities of exceedingly rich silver-lead ore. It is to be assumed that in the upper workings the Chinese mined out most of the ore of this character leaving only patches of it here and there. The ore reserves naturally increase very rapidly in an orebody of such great size as lateral development proceeds at the different levels. The Technical Committee of the Burma Corporation Ltd. estimated the reserves of proved and probable ore to November 1914 at 1,310,000 tons having an average value 19·8 oz. silver, 23·2% lead, and 21·6% zinc. In August 1915 the estimate of reserves was 2,000,000 tons averaging 25 oz. silver, 27% lead, and 22½% zinc. This augurs well for the final tonnage which should be exposed above the Tiger Tunnel or No. 6 level, when the full area of ore has been opened up on each of the Nos. 3, 4, 5 and 6 levels.

MINING AND TREATMENT.—The early history of the financial difficulties, the formation of the different companies, railroad building, the smelting of old Chinese slags for lead and silver, the development of the lodes, etc., has been briefly stated, and there still remain the important considerations relating to the metallurgical treatment and disposal of the various classes of ore, and the methods to be used in mining them.

The methods of mining the ore are dependent upon factors which are as yet not definitely solved. The assay plans of the mine show that large bodies of different classes of ore occur in compact masses, and that selective mining can undoubtedly be done. Selective mining may therefore control details of the method of extracting the ore. The methods of stoping which will be found practical and commercially advisable can only be finally determined after a thorough study of all the questions involved, the metallurgical results which can ultimately be obtained from concentration, smelting, etc., and the selling contracts for ore and concentrates. These questions are in capable hands, and no considerable difficulties are expected.

The Bawdwin ores are complex in nature, and members of the technical staff have been alive to the necessity of making many tests to ensure a practical and commercial separation of lead and zinc concentrates, and for their treatment or disposal. Before the war a good profit was made from shipments of 2000 to 3000 tons of ore per month to Europe, showing that there is a good market for certain ores without preliminary treatment.

A large shipment of ore was made to the Zinc Corporation at Broken Hill and treated in its testing works with encouraging results. A testing plant was erected at Namtu, and operated on a small scale for about one year. The results warranted the enlargement of this plant to a capacity of 100 tons per day, the mill to be utilized not only for experimenting, but to crush ore and to make concentrate for the lead smelter. The mill has been completed, and is now sending about 500 tons per month of crushed high-grade silver-lead ore and concentrate to the roasters, whence it goes to the smelter where it is smelted with the slags. The chairman of the technical committee stated in his speech before the shareholders at the last annual meeting that this procedure would be continued during 1916, substituting more ore and concentrate for slag as the latter becomes exhausted. It is expected in this way to realize a profit over all expenditure for the year.

The metallurgical position may be briefly summed up as follows: Experiments in concentration have shown that lead and zinc concentrates can be made which indicate a profit of about £2. 10s. per ton of average grade ore, but more testing is required to perfect this separation in order to minimize the metal losses and increase the profits. The smelter can continue to make good profits from silver-lead ores as at present. After the war, no doubt, the zinc concentrate and certain picked ores can be shipped and sold as formerly. As soon as methods of concentration have been decided upon, the erection of the treatment plant will be started and eventually it will be enlarged to treat about 300,000 to 350,000 tons of ore per annum. On this basis it is not unreasonable to say that the mine promises to become the largest single lead-zinc-silver producer in the world.

The Hargreaves-Bird electrolytic alkali process, after many years of vicissitude, followed by a drastic reconstruction of the company and change of control, is now being worked at a profit, at Middlewich, Cheshire.

GOLD MINING AND THE POUND STERLING

By F. H. HAMILTON.

The proposal of the Canadian Government to impose a profits tax on gold mining, in connection with the increased taxation in this country, raises serious questions as to the effect upon gold mining and the output of British mines. These questions demand consideration.

THE decision of the Canadian Government to impose a tax of 25% upon profits in excess of 7% per annum on paid-up capital upon all enterprises incorporated in the Dominion, affords a convenient opportunity of considering the whole question of the taxation of gold mines within the Empire. It is not easy in the middle of this world cataclysm to see very far beyond one's nose, and the conclusions which I am about to suggest are necessarily tentative, but, if I am right, the matter is urgent, it is of great importance to this country, and a mistake in policy may easily be irreparable.

It seems to be assumed that taxation such as is now proposed in Canada, or such as our own excess profit tax, affects a gold mine pretty much as it does a manufacturing concern. This is not the case. A gold mine is a wasting asset, generally with a relatively short life. Every ounce of gold taken out of the mine decreases its value, and every year's output diminishes it in a calculable measure. For this reason, allowance should be made, not only for depreciation of plant, but for redemption of capital, and obviously a dividend of 7% from a railway and a gold mine has quite a different value. In the one case, it is a high, and, in the other, an entirely inadequate return. Investors always and rightly demand a higher return from mines than from industrial enterprises, but the factor of redemption is invariably ignored by Governments. A further reason which differentiates the taxation of gold mines from that of any other form of industry is that whereas other products can accommodate their price to an increase in the cost of production, gold, being the fixed standard of value, cannot do so. Since that fateful August 1914, practically all other metals, with the exception of silver, have appreciated enormously. Copper has risen from £61. 5s. to £107. 15s. per ton, spelter from £21. 10s. to £95, pig-iron from 51s. 4d. to 86s. per ton, and lead from £18. 10s. to £32, but the price of gold, expressed as it is in terms of itself, is nominally unchanged. Actually its value, which can only be measured by its purchasing power, has decreased, since the price of commodities has appreciated since the war by an average of more than 45%, and the real value of gold has obviously depreciated in the same proportion. Hence all taxation, even when not levied directly upon gold mining, hits it, not only by increasing the cost of production, but by decreasing its real value. I am not suggesting for one moment that gold mining should be exempted from its fair share of taxation, but I do state that legislation which ignores the factors I have mentioned and which regards the profits derived by a gold mine and a shipping or a railway company as identical for purposes of taxation, is essentially penal, and will inevitably result in a reduction of the gold output within the British Empire.

It might be possibly argued that this result is desired, though I do not think it is, but in either case, it is well to be clear about the fact. The effects will probably not become apparent for a year or two. Gold mines actually producing will continue to produce until such time as wages, cyanide, dynamite, plant renewals, etc., have reached the point at which profitable production has become impossible. The margin in a number of cases is already perilously narrow. Thanks to the advance in metallurgy and the improvement in recovery processes, the bulk of the world's gold is today recovered from ores with a value of between 20s. and 40s. per ton. The lower grade mines are often large producers, but the actual profit per ton is small, and they are, in many cases, already near the point at which even a slight increase in costs will put them out of business. A more important point, however, is that gold mines, being wasting assets, are dying out every year, and that the world's output is only maintained by new mines coming into production. You can do nearly everything with bayonets except sit upon them, and Governments can do nearly everything with taxation except force enterprise and capital into channels which are penally taxed, and obviously capital will, for the reasons I have stated, tend to fight shy of gold mines. The prospector will cease to look for them within the British Empire, knowing that he cannot find a market for his wares, and in two or, at the most, three years time, the effects on the world's production will become apparent. An illustration very much to the point is afforded by the gold mining industry of Ontario. Last year, the production of the Province of Ontario showed an increase of 50% over that of 1914, a higher rate of increase than that of any other field in the world, and a further large increase was looked for during this year. The labour is neutral or nondescript, the engineering largely American, and capital from the United States was beginning to flow into the fields in increasing volume. That movement will, of course, be definitely stopped. It will be quite beyond the powers of any finance minister to convince the American investor that a dividend from a gold mine from which in calculating the net return he has to subtract redemption, is the same as a dividend from an enterprise in which no such allowance has to be made, and it will be equally difficult to convince him that having regard to the disappointments and difficulties inseparable from gold mining, 7% is a reasonable rate of interest on such mines as he may happen to find. Nor is it possible that when once prospecting and mining activity have been stopped by legislation, they will be resumed when the cause is removed, and the taxes suspended or abrogated. The process of reconstitution must be a slow one extending over years, and, while it is going on, the gold output from the Empire will suffer. If the yield of the taxes proposed by the Canadian and our own Governments were likely to be considerable, the present needs of the State might be held to over-ride all considerations of inequality of incidence and indirect disadvantages. As a fact the yield will be negligible. The total output from Canada for 1915 is estimated at £3,863,000, and, assuming that £1,000,000 of this represents profit to shareholders—a very generous estimate—it is inconceivable that the net annual yield to the Canadian Government can very much exceed £150,000. It is also difficult to estimate the revenue derivable from our own excess profit tax so far as it applies to gold mines, but it will certainly be a very small one. It can only be levied on mining companies registered in Great Britain, which constitute only a small proportion, and the tendency will, of course, be for these companies to transfer their domicile to the colony in which their property is situated. On the whole, it is highly unlikely that the annual yield to the State will be more than £300,000, and it may easily be much less. It would, I think, not be difficult to demonstrate that in all probability the net result of the excess taxation in this country and Canada on gold mines will be a loss to the revenue of the respective Governments over the next few years.

If it be true that this excess taxation, besides being inequitable as to its incidence and insignificant as to its yield, will tend permanently to reduce the world's output of gold, the question remains whether this is a desirable result. Here we are verging upon deep waters. There are two schools of thought which will return two wholly divergent answers. The prevailing view is perhaps best represented by Sir E. H. Holden, who, in his important address to the shareholders of the London City and Midland Bank last month, summarized one part of his conclusions as follows:

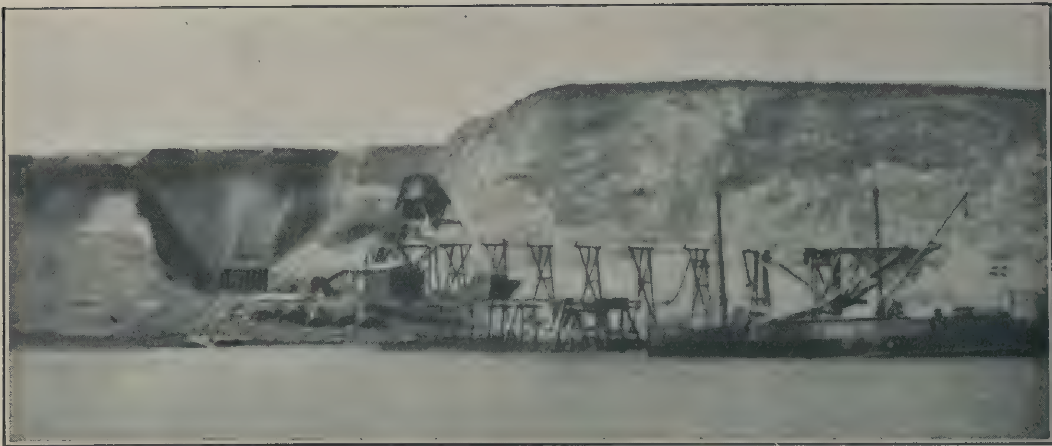
"London, as I have before explained, has maintained and will continue to maintain the position of being the financial centre of the whole world, but it can only retain that position by being able to supply gold when gold is demanded. The Bank of England has at the present time about 50 millions sterling of gold. The Government has 28½ millions, and the joint stock banks have a further large sum, while I believe there is yet in hoarding a fair amount, and we are fortunate in having a continuous flow of gold from South Africa. If, on the conclusion of this war, we are still a free market for gold, we shall have scored a financial triumph as important to the country as a great victory in arms."

Presumably this is also the view of the Government, but, in that case, the maintenance of the gold output should surely be encouraged not penalized. I do not propose to venture to do more than touch upon the outskirts of the deeper economic questions involved, but there are one or two considerations that have an important bearing upon gold mining. The first is that the interests of the Empire would appear to be somewhat conflicting. On the one hand, we are piling up a huge public debt ultimately redeemable in gold. Now it seems clear that at the end of the war it will be to our interests, and indeed to those of all the belligerent governments, to encourage a further inflation of the price of commodities, since every such increase represents an almost proportionate reduction in the actual as opposed to the nominal indebtedness. On the other hand, every increase in the price of commodities means a decrease in the purchasing power of gold. Now it is perfectly true that gold production is only one and by no means the chief factor in determining prices, but it is a factor, and it is certain that if the gold standard is to be maintained, the demand for the metal will be great and urgent. Ultimately, the credit of a government owing, say £4,000,000,000, will be determined by the general belief in its ability to redeem its promise to repay in gold, and the larger the available reserves the more general will that belief be. It is no less certain that every increase in the price of commodities means an increase in the cost of producing gold, and that we are today not very far from the point at which many of the low-grade mines would have to quit business. Now there is, no doubt, more than one way of escape from the dilemma. The bi-metallists and the advocates of 'soft' money generally are ready with their suggestions, and indeed it will be remarkable if their arguments are not strongly reinforced by the conditions which will surely prevail after the war. A premium on gold, which is practically another way of expressing a depreciation of currency, suggests another answer. I am, however, assuming that it is always to the interest of Great Britain to uphold the pound sterling "that wonderful instrument" to quote again Sir Edward Holden "which is really the English sovereign with a minimum weight of 122·50 grains and a maximum of 123·274." I have no doubt that Sir Edward Holden's view is the right one, even from the standpoint of world prosperity, but, without entering upon the deeper questions involved in the maintenance of the single standard, one or two obvious points must be borne in mind which especially affect the British Empire. The gold production of the whole world during the year 1915 is estimated by *The Mining Magazine* at £97,852,300, of which £60,120,000 comes from the British Empire, rather over £8,000,000 from Russia and Japan, and rather over £20,000,000 from the United States. In other words, the Empire produces over 60%, our Allies over 8%, and the United States over 20% of the total. Our enemies are non-producers. The prosperity of South Africa, than which no part of the Empire has rendered finer service, is largely based upon gold. I venture to think that even if it could be shown that the yield from the proposed excess taxation were great instead of quite insignificant, if its incidence were fair instead of grossly unequal, the policy of discouraging gold production at this moment would still be singularly short-sighted.

Finance ministers just now are sorely tried individuals, and much may be forgiven them, but the whole policy involved in recent proposals is likely to have more far reaching effects than seems to be contemplated. No harm can be done, and much good might result by the addition of one more to the numerous Commissions which have recently been appointed. Doubtless the Colonial Governments concerned would co-operate. The investigations of such a Commission might be usefully directed toward determining whether legislation affecting gold production is not a matter of Imperial rather than local concern, whether a further rise in the price of commodities will restrict the output of gold, what is likely to be the yield from gold mines of the excess taxes levied or proposed by our own and the Canadian Governments, and whether, and if so to what extent, such taxation will tend to discourage production. An investigation of this kind should not be a lengthy one, but its results would, I think, be illuminating.

Manganese Ore in Wales.

Not more than a few thousand tons of manganese ores are produced per year in the British Isles, and nearly the whole of this comes from the Lleyn peninsula in Carnarvon. In earlier days, ore was mined in Devon and Cornwall, and the deposits are not exhausted, though at present prices they cannot be worked at a profit; the chief deposits are found near Launceston in north Cornwall and at Brentor in western Devon. The vast resources of the Caucasus, Brazil, and India have quite eclipsed the British deposits, both as regards extent and metallic content. The chief ores in the west of England are pyrolusite and rhodonite, and rhodochrosite predominates in Wales. In Carnarvon, the Nant, Benallt, and Rhiw mines are in the hands of the North Wales Iron and Manganese Co., of Liverpool. At Nant, the undecomposed ore contains manganese in the form of carbonate with a small proportion of silicate, and at the outcrop as hydrated black oxide. It occurs as a bed from 10 to 20 ft. thick in the Lingula flags and shales of the Ordovician age. The ore at these mines averages 30 to 36% manganese, 7 to 10% iron, 18% silica, and 0·3 to 0·5% phosphorus. At the present time only the Nant mine is being worked, and the output is 4000 tons per year. The above information is taken from a memoir of the Geological Survey relating to tungsten and manganese resources of the United Kingdom recently published.



Open-cut Workings and Loading Station.

DIATOMACEOUS EARTH DEPOSITS IN DENMARK

By E. A. MANNERS.

IN the early part of 1914 I had occasion to study certain unusual deposits in northern Denmark that pass under the local name of 'moler.' This name comes from 'Mo,' an abbreviation for the island of Mors, upon which the principal deposit occurs, and 'ler,' the Danish word for clay. The material, however, is not a clay in the ordinary acceptation of the term. It consists in fact of about two-thirds diatomaceous earth, or kieselguhr, and one-third fine clay. Diatoms are unicellular algae living in both fresh and salt water, and they have the ability to secrete silica, storing it up in the walls of the cells until the latter become saturated with it. When the plant dies, this exterior silicious skeleton remains, and such materials in Tertiary times accumulated in quiet waters, forming large deposits. The diatoms are of microscopic size, and the silicious skeletons formed by them are very light, consisting of thin-walled cells. Thus a mass of diatomaceous earth has the property of being able to absorb large amounts of liquids, and it is this property which gives it value in the arts, for instance in the manufacture of dynamite to absorb the nitroglycerine. Its porosity and the multitude of small air spaces contained makes it an excellent non-conductor of heat, which property is increased in value by the fact that the material itself is incombustible.

Diatomaceous earth, in order to be of use, must be made to cohere into blocks, and this is done by mixing it with clay which serves as a binder. As there is a great difference in the specific gravity of the diatom shells and of the clay, if is not easy to obtain a perfect mix. It is this circumstance that gives particular value to the moler deposits, because there the

Map of Denmark, with the 'Moler' islands in black.

NEARER VIEW OF WORKINGS IN OPEN-CUT.

clay and diatoms occur together ready mixed in just the right proportions.

The deposits are on the islands of Mors and Fuur, in northern Denmark, within 12 hours journey from Copenhagen. Mors is the larger and better known island and, as it happens, contains the larger of the two known deposits. The waters surrounding the island are navigable, and ships up to 13 ft. draught can enter the small harbour. The moler is exposed in cliffs running 50 to 150 ft. from the sea, and lies in horizontal beds like ordinary clay. It extends back under the uplands to a distance not yet completely determined by prospecting. The principal deposits upon the island of Mors are controlled by the Frederiksholm Teglog Kalkvaerkers Kontor. On the island of Fuur, a deposit of 13 acres is controlled by the same company. The deposit on Mors has been opened by means of a cut 200 by 200 ft. in area and 85 ft. deep. In addition four 80 ft. test-pits have been sunk,

VIEW SHOWING CLIFFS OF SOLID MOLER.

300 to 1000 ft. inland and 650 ft. apart. Numerous bore-holes have also been put down. A well 60 ft. deep, sunk in the open-cut, was still in moler. It is estimated that about 10,000,000 tons of material is available. The Fuur deposit has been less explored, but may be estimated to contain at least 400,000 tons. The company has mined and shipped about 65,000 tons. Most of this was worked up in Denmark, but part went to Norway and Russia, and a little to England. In 1913, a subsidiary company was formed, and erected works at Stettin to supply the German trade.

The principal use of moler so far has been in the manufacture of insulating bricks, slabs, and other shapes. Tests made in the physical laboratory of the Polytechnic Institute in Copenhagen, according to Professor H. J. Hannover, show that the coefficient of heat transmission for moler brick is only 0·00064, while for ordinary brick it is 0·002. The material is therefore in demand for boiler-settings, pipe coverings, and similar uses. A moler brick weighs just about one-half as much as an ordinary brick of equal strength. For interior partitions and fire-proof covering of steel work the material is specially valuable. Its lightness gives it important advantages even in ordinary construction work, as the bricks may be made twice the usual size, using therefore only half the usual amount of mortar and decreasing the labour of construction, while still having the same strength. This also makes possible the carrying of a higher wall on the same foundation, and a case is on record where the authorities granted permission for the erection of an additional storey on an existing building, provided the walls were made of moler brick. Moler is also finding its way into a number of minor trades, and has been shown to be available as a substitute for plaster of paris moulds in metal casting, as a filler for making cement similar to 'sand' cement, and in a wide variety of cases as an insulating material. It is for this last-named purpose that it is being rapidly introduced on shipboard, where lightness is so important. Shortly before the war, plans were in hand for the formation of a British company, and for the introduction of moler on the English market. That project, however, is for the present in abeyance. No doubt with the return of peaceful conditions, there will be opportunity for the engineering trades in this country to get the benefit of using this material in construction work.

COMMUNICATIONS WITH RUSSIA.

It is appropriate at the present time to give some information relating to the trade routes between the British Empire and Russia, and of the regulations with which shippers of goods must comply. Five routes may be considered. The first is through the port of entry of Vladivostok and the Trans-Siberian railway. This route is suitable for Australian, Eastern, and Canadian produce, and if the service were dependable the Panama Canal might in some cases be used for shipments from England. Of the other three routes, only one is available at this period of the year, namely, through Norway, Sweden, and Finland. Freight can be sent to the Norwegian ports of Christiania, Bergen, Trondhjem, or Narvik, thence by rail either to some Swedish port on the Gulf of Bothnia and by steamer to a Finnish port, or by rail through Sweden to the north of the Gulf of Bothnia where communication is made with the Finnish railways at Tornea. Intending shippers must ascertain whether their goods require licence from the Swedish government. If the goods are intended for the Russian government, applications for licence are to be made to the Commission Internationale de Ravitaillement, at India House, Kingsway, London; if for other destinations, to the War Trade Department, 4 Central Buildings, Westminster. In the applications full details of the goods and the value must be given. The applications are forwarded to the British and Russian Legations at Stockholm, who negotiate with the Swedish government for transit licences. When the latter are granted, the usual shipping licences are issued in this country. All goods, whether requiring licence or not, must be consigned to the firm of Lars Krogius & Co., whose headquarters are Helsingfors, Finland, and who have branches at all the Finnish ports. Through rates to a Finnish port must be prepaid.

The other three routes are by sea direct to the northern shores of Russia. The port of Archangel, on the White Sea, has long been the port for North Russia. It is, however, ice-bound for five months of the year, and the railway 400 miles long connecting with the main system at Vologda is narrow gauge. At the present time the conditions are being improved. The gauge is being altered to standard, the increasing use of ice-breakers prolongs the shipping season, the removal of the docks farther toward the open sea is in hand, and a bridge is being built over the Dwina river. An alternative port to Archangel is at Kola, in Ekaterina harbour, near the Norwegian border. This port has the advantage of being ice-free all the year round, for though farther north than Archangel it comes under the influence of the Gulf Stream. The long-contemplated line of railway connecting the port with Petrograd is under construction. The section between Kola and Kandalaksha on the White Sea is nearing completion. The section between Kandalaksha and Ivanka, the junction with the main Russian railway, 75 miles east of Petrograd, is in course of construction, but the date of its completion cannot yet be given.

The sea-route to Russia remaining to be noticed involves the passage of the straits between Russia and the island of Novaya Zemlia, and of the Kara Sea to the mouths of the Obi and Yenesei rivers. This route is of restricted value, because it is obstructed during the greater part of the year by drift-ice, and the ships engaged in the traffic can make only one journey each year. The Russian government is doing everything possible to facilitate navigation, and has established wireless stations on Novaya Zemlia and on Veigach island for the particular purpose of warning vessels with regard to ice conditions. The ships, on reaching the mouths of the Obi and Yenesei, discharge their cargoes into river barges, which are carried southward by means of steam-tugs. The river services are being extended and improved in order to encourage this northern route. Of the rivers, the Obi, and its tributaries the Tobol and the Irtish, provide communication with the copper mines in the Southern Urals and Eastern Siberia and with the lead-zinc mines of the Altai. The navigation of the Arctic Sea to the eastward of the mouth of the Yenesei is impossible owing to the northerly trend of the land, so that communication with the mouth of the Lena is out of the question.

Map to illustrate communications between Great Britain and Russia.

As regards postal communications with Russia, letters, newspapers, and book packets continue to go by the route through Norway, Sweden, and Finland. Correspondents state that registered book packets are delivered safely, but complaints often arise with regard to the non-delivery of newspapers, and occasionally of letters. The parcel post service through Sweden is at present suspended, and during the winter the route via Archangel is not available. As the railway communication with the open port of Kola is not completed, the only route for parcel post at present is by way of Canada and Japan.

DISCUSSION

Glass-Top Concentrating Tables.

The Editor:

Sir—Having myself made exhaustive tests, which I hope to publish later, to compare Martin's glass-surfaced table with the ordinary Cornish wooden deck round frame, I studied with much interest the trial made at the East Pool & Agar mine, as recorded in your issue for January. I trust the test will be carried on until it becomes exhaustive and complete. As it now stands, it is difficult to arrive at definite conclusions. Mining engineers, who are not familiar with Cornish practice, will be surprised at the small amount of concentration effected in the operations recorded.

Take the case of the wood frame. It only succeeds in saving 44·4% of the contained tin, in the form of 15 lb. concentrate, from a pulp assaying 9·2 lb. This low concentration is of course explained by the pulp being an intermediate product in the mill treatment, and when it is considered that the material assaying 15 lb. has to be further treated before it reaches a marketable form, the tedious and exhaustive concentration commonly required on Cornish low-grade sands must be apparent.

Glancing at the extractions of metallic tin as recorded by Mr. Taylor, namely: glass 34·7%, wood 44·4%, it might at first sight, by the untrained mind, be supposed that the better work had been done by the wood; but taking the test as it stands:

	Glass frame lb. per ton	Wood frame lb. per ton
Feed	9·2	9·2
Concentrate	32·2	15·0
Tailing	6·5	6·5

it is evident that to make the glass-frame extract exactly the same amount of tin as the wood, it would only be necessary to run a certain proportion of the glass-table tailing into its concentrate and so produce a 15 lb. concentrate equal to the value of the wood concentrate. Obviously the glass deck has done better work, for the wood-deck concentrate would have to be re-treated to bring it to the value of that of the glass. Secondary operations of this kind always produce tailing of a higher assay-value than the first, and as this added loss continues at each effort at further concentration, it might be found at the stage where the concentrate reaches the tinyard for final dressing that, instead of the wood having the advantage of roughly 10%, the glass table would show a benefit to that extent or more. That the test showed the glass concentrate to contain a greater proportion of arsenic and copper might have a valuable significance, and I hope Mr. Taylor will make public the results in this connection, when he carries his tests further after remedying the structural defect in the glass table to which he draws attention.

Interesting facts might be elicited by the examination of the shapes of the particles of tin oxide in the pulp, and subsequent examination of those contained in the concentrate and tailing.

In the case of my own trial, it was found that where the particles were seen to be of spherical shape under the microscope, the fluted glass was better able than the wood to retard their rolling action, and thus affect their tendency to loss in the tailing. The fact that the glass frame can probably treat more than one-and-a-half times the quantity over the same period than the wood frame is a valuable advantage, and would necessarily have to be taken into consideration in the erection of a new plant.

In making a trial of this kind, one is naturally inclined to work the old and new machines under nearly the same conditions. There are several considerations which have to be borne in mind to procure good work. Any alteration in the following will greatly affect the concentrating ability of the table: (1) The grade and specific gravity of the dry material to be treated, (2) the pitch of the flutes of the glass surface, (3) the proportion of water to dry material in the pulp, (4) the speed of travel of the table, (5) the slope of the deck, (6) the tonnage passed over the frame, (7) the amount of wash water.

In the case of the wood frame, given No. 1, then 3, 4, 5, 6 and 7 are well known to all tin dressers in Cornwall. For the glass frame, it may take a considerable amount of experimenting to determine them, and in any case, where a trial is made, it would be helpful for others if the person conducting them would make a record of each. It will be readily understood that the choosing of the correct kind of glass for use as a surface is a most important matter.

A rough method of finding the correct pitch of the glass flutes is to place a square of each particular kind of glass at the head of the table, and allow it to pass under the streams of pulp and wash water. When it has made one revolution it is removed, and the concentrate washed off, weighed, and assayed.

In fixing the proper glass for my own test, 10 glasses of different pitch were tried. The one giving the highest extraction, consistent with a proper degree of concentration, was chosen.

Other mines in Cornwall have made similar trials, and if the good example set by Bewick, Moreing & Co. in making public the results are followed, some valuable information might be disclosed.

ROSS MACARTNEY.

Redruth, February 2.

The Editor:

Sir—A thorough appreciation of the points made in your leading article on the above subject, before studying the results published on page 32 of your January issue, should prevent the formation of erroneous conclusions. As you say, there may be profit in accepting the extra tailing loss and obtaining the higher grade concentrate, and in the test under consideration, Martin's glass-top table has undoubtedly done better work than the wood-top table, owing to the higher grade concentrate obtained together with its superior capacity. To bring the wood-frame concentrate up to the grade of the glass-frame concentrate would necessitate another operation, entailing a loss of at least 20% of the contained tin. The recovery would thus be about equal in both cases, but to achieve a certain result in one operation instead of two is a considerable gain.

With regard to your comment concerning the slopes of the two tables when dealing with similar feeds, it is questionable whether, in order to compare results, the conditions should be different. The ordinary Cornish round frame can be made to give products of widely varying value by altering its speed of rotation and the amount of cleansing water used.

It may be taken for granted that, generally speaking, a wood-topped round frame in an old-established Cornish dressing floor is doing the best possible work for that type of machine. To ascertain whether a glass table can do better work than a wood table, I would endeavour to make the glass table yield from a given feed a concentrate equal in grade to that obtained from a wood table. This could be done by making the necessary adjustments of slope, speed of rotation, and amount of wash water used. Has Mr. Taylor cut off his glass-table concentrate at such a point as to make a concentrate equal in grade to the wood-table concentrate?

It may not be generally appreciated that the consistency of the pulp going on to a round frame has an important bearing on the extraction obtained; the proper pulp consistency has to be ascertained in each case, and it may be that a glass table requires very different feeding from a wood table. But, as you say, a complete scientific study of the applicability of glass-topped tables is yet to be made.

Mr. Taylor and his firm are to be congratulated on having commenced such an investigation, because the concentration of tin ore, as practised in Cornwall, has attained a high degree of economic efficiency, and anything which will lead to the improvement of those Cornish methods, which are the outcome of generations of hard thinking, is of importance to the community in general.

M. S. STUTCHBURY.

London, February 1.

To the Editor:

Sir—I read with much interest the article of Mr. Trewartha-James and the letter of Mr. W. Morley Martin on the glass-top concentrating tables, but a most important factor appears to have been left out, and it is one which greatly affects all round slime concentrating tables and more especially one with such a sensitive surface as glass, and that is the efficient sizing of the pulp before being fed to the table.

It is obvious that if we have two particles of any mineral, say cassiterite, and of the same specific gravity, and a stream of water pushing behind them, the retardation of a surface will affect both particles in a like manner. Now if one of the particles is ten times the size of the other the surface contact in the case of the larger particle is greater and consequently retardation will tend to be greater; but this is completely overbalanced by the considerably larger area exposed to the oncoming water, and it is consequently washed forward and lost, in the case of a wooden surface frame. This appears to be precisely what is prevented in Mr. Martin's fluted glass. Now substitute a particle of gangue for the larger particle of cassiterite and the flutes will catch this also, but if this gangue is the same size as the tin particle then the tin will, owing to the eddying effect of the water flowing over the flutes, displace the lighter gangue, which again comes under the influence of the flowing water. There is a case in point in Cornwall at a large concentrating plant where pulp is fed to the round frames having particles of cassiterite, to say nothing of the gangue, differing in size by ten times, and it is very doubtful if this is by any means an isolated case.

No tin dresser would attempt to buddle 'crop' tin and 'slime' tin at one and the same time. Yet carrying the process to within microscopic dimensions, results are expected from such a procedure on so delicate a piece of apparatus as the round frame, with the result that there is £300,000 worth of tin lost to the mines annually, the greater part being fine slime tin. The losses of 'crop' and 'size' tin at the mines are infinitesimal, because such tin is under close observation and carefully classified before reaching the tin yard. If such care and more was exercised in the matter of accurately sizing the slime pulp to several grades and treating each grade separately, as in the case of the coarse tin, it would go a long way toward solving the problem of the fine tin losses.

M. GREGORY.

Redruth, February 24.

Losses in Tin Recovery.

The Editor:

Sir—I am glad to see Mr. G. H. Blenkinsop's letter in the February Magazine. Everybody in Cornwall is interested in the result of his trials of what has been called a 'decrepitation process' for disintegrating tin ore by preliminary heating and cooling before crushing. A similar method has for some time been in successful operation on a complex cassiterite-wolfram-monazite ore. In this case ordinary methods of crushing and concentration were installed, but no commercial recovery could be obtained until heating and quenching the ore before crushing was tried.

The Waterberg ore appears to be peculiarly well suited to this method of treatment, and it seems surprising that more attention has not been given to it. The excessive comminution of cassiterite produced in Cornish ores by crushing with stamps will shortly receive general attention, and I may say that the question of trying the method mentioned by Mr. Blenkinsop on Cornish ore has already been under my consideration, and has been discussed with some of our industrial leaders.

We may expect to find that Cornish tin ore may be much more difficult to deal with, and will not be so amenable to this process as the Waterberg ore, for obvious reasons, namely, the dissemination of the tin oxide in an extremely fine state of subdivision, and the character of the matrix.

Mr. Blenkinsop's suggestion to try high-speed rolls instead of heavy stamps appears to be on the right lines; but Cornish ore will require finer grinding than is practicable with rolls, though it may be desirable to use rolls down to a product of say 10 or 20-mesh.

This method of rendering ore friable is a very ancient one, and it is an interesting instance of a reversion to early methods which have been in disuse for many years.

W. H. TREWARTHA-JAMES.

London, February 23.

Caving Methods of Mining.

The Editor:

Sir—I have read with some surprise a letter from Mr. A. G. White in the October Magazine, page 214, praising a system of stoping in use at the Cabezas del Pasto mine. Is it possible in the twentieth century that such a wasteful system should still be in use, and a counsel found to praise it? Of course everything depends on cost of labour at the mine, but be labour ever so cheap, it is not excusable to waste it.

The system described is principally for use in stocks and wide lodes, and consists of driving first on the strike, along the hanging wall of the orebody, and from this drift cutting cross-cuts 30 ft. apart to the foot-wall. Another drift is driven in the solid hanging wall 15 ft. from the lode, for the tramming road. As each cross-cut is finished, it is filled with stone from surface, and another so-called cross-cut stoped out alongside, which in its turn is filled with waste, and so on. The drift along the hanging wall is also filled with waste, and the process repeated in the first stope above the level, and so on until the block is worked out. Levels are driven 70 ft. apart.

If the orebody is at all regular, 70 ft. is too close for economic development; 100 ft. decreases the cost of development 30%; but I will not labour that point, as with very irregular orebodies even 70 ft. may be too much.

To open up an orebody say 90 ft. long and 15 ft. wide by the system described, 240 ft. development in the solid is required, that is 2 drifts each 90 ft., 3 cross-cuts each 15 ft., and at least one cross-cut from the tramming road to the lode. I should open the same orebody with 105 ft. of solid driving, and have four faces of attack at once, and in a few days, as the body gets stepped, many more. The Cabezás del Posto system also must abandon for ever the whole area of the stope underfoot, say in No. 1 level. This cannot be mined on rising from No. 2 level without bringing down the whole of the filling above.

What does the handling of ore and waste cost in this system? When the level is worked out *and filled*, how is the ore brought to the tramming road, and what does it cost? Still worse must be the cost of labour to get the waste rock up to stope after stope. Even if passes are cut up to the level above, and the waste passed down, it must take some handling to distribute the waste.

Again, in packing the worked drift and crosscuts every stone must be handled separately, and built into a dry wall, or else when the ore alongside is blasted out, down will tumble the filling, and it will be necessary to separate filling and ore if possible after every blast. Generally the system is full of holes to increase expenditure, and it would be interesting to hear again from Mr. White, and especially to know costs.

WALTER J. STANFORD.

Ulen Copper Mine, Siberia,
November 23.

The Rand Conglomerates.

The Editor:

Sir—I have been much interested in the papers on the geology of the Rand, by Dr. E. T. Mellor, recently published in *The Mining Magazine*, because of certain points common to the series of suggestions put forward by me in 1907 in the discussion on a paper on 'The Origin of the Gold in the Rand Banket,' by Professor J. W. Gregory, read before the Institution of Mining and Metallurgy in 1907. The points in common are:

(1) Characterization of the beach-placer hypothesis (at that time in the foreground), as the main stumbling-block to the general acceptance of the view favouring the detrital origin of the gold. In this connection, it may be remarked that no live geologist, or even a geological student, has doubted for the past twenty years or more the possibility and, indeed, the probability of the present crystalline state of the gold of the Rand being due to dissolution and re-deposition, granting that the gold was already in a very finely divided state when it was incorporated in the sediments.

(2) Insistence on the wonderful relative persistence and uniformity of the conglomerates, and on the very fine character, the wide distribution, and the comparatively uniform and great amount of the gold in the banket as deciding factors in the problems.

(3) Recognition of the analogy of the Witwatersrand System with strata formed under typical deltaic, submarine deltaic, or circum-deltaic conditions.

(4) Postulation of oscillations of level, or of pauses in subsidence of the area in question.

(5) Postulation of the concentration of the gold by the action of waves and currents from material deposited in water below low-water mark.

It is true that on certain details we differ in our views; for instance: (*a*) mode of origin of the pebbles, (*b*) mode of transport of the pebbles, (*c*) manner and degree of their concentration from sediment.

Mr. Mellor's description of the deltaic and extra-deltaic conditions which he postulates is almost nominal, and is consequently not open to much discussion, but it seems evident that he lays far too great a reliance on floods as a means of transport and arrangement of the pebbles in sheets. "The accumulation of such enormous quantities of well-rounded pebbles" of such uniform size and mineral composition in the lower reaches of a river and the upper portions of its delta, and without admixture with angular and subangular stones of quartz and other minerals and rocks is highly improbable, and it is to be noted that he brings forward no evidence of such accumulations in nature. And one may fairly question the capability of a flood to classify and distribute such a load suddenly, in so uniform a manner, over such a vast area, and with so little localized wear and tear on the sea-bottom. Moreover the possibility of such deluges seems very remote.

Without appealing to cataclysmic or catastrophic explanations, there are two or three hypotheses which attempt to account for such interstratified conglomerates in a more probable because more gradual and less strained manner. The one which I selected to put forward in 1907 has the outstanding merits of explaining (1) the gradation between compact pebble beds, through bastard beds with separated pebbles, then pebbly sandstones (or quartzites) to sandstones with occasional pebbles, (2) fairly or sharply defined roofs and floors to such beds, (3) well-marked narrow partings of sandstone or quartzite.

In the further discussion of this most interesting subject I hope these alternative suggestions will not be overlooked.

L. H. COOKE.

Royal School of Mines, March 4.

SPECIAL CORRESPONDENCE

JOHANNESBURG.

GOLD OUTPUT. — In the Johannesburg letter appearing in the December Magazine mention was made of the possibility of the gold output for 1915 approaching if not exceeding that of 1912, the record output year of the Rand. From the figures published by the Mines Department it would appear that the gold output for last year has actually exceeded that for 1912, the output of fine gold being 8,771,919 oz. as against 8,731,969 oz. in 1912. The sterling value last year was £37,260,746, as compared with £37,091,050, in 1912. Considering that last year was a period of war and rebellion, this achievement was a notable one, especially in the face of the continued decline of gold mining in the Central Rand, and brings into prominence more than ever the good results achieved during the year by several mines in the Far East Rand. Then again the comparative abundance of unskilled native labour has had something to do with the increased output, statistics showing that practically throughout the year the supply of native labour continued to improve.

Next to the increased production of gold, the huge increase in the tonnage milled is a striking feature of the 1915 returns. Last year the tonnage milled reached 28,355,179 tons as compared with 25,732,967 in 1914, and 25,657,235 tons in 1912. This increase has been a striking feature every year on the Rand, even when the production of gold has not increased, thus showing that owing to the fall of grade in the deep level mines, a larger tonnage must now be crushed to produce the same amount of gold.

If recourse be had to the returns published by the Chamber of Mines it will be seen that the yield per ton milled still continues to decline, that for 1915 being 26s. 3d., the lowest yet recorded. Working costs per ton crushed have increased as compared with last year from 17s. 1d. to 17s. 5d., the wonder being that they have not increased to a greater extent, when the extra imposts and dearer stores are taken into consideration. Working profits and dividends at 8s. 5d. and 5s. 4d. per ton respectively are also the lowest on record, and despite the huge output of gold last year, the total amount paid in dividends compares unfavourably with those paid for the last nine years. The gold mines outside the Rand area did badly, so much so that the Transvaal record output is still held by the year 1912.

THE COAL TRADE of all the South African provinces except the Cape showed a small improvement last year in volume, as compared with the previous year, but the pre-war position has not yet been regained. The total sales last year reached 8,281,311 tons for the whole of South Africa, as compared with 8,477,923 tons in 1914, and 8,801,216 tons in 1913. Prices as compared with the previous year show little change. The Transvaal output was 5,202,805 tons, as against 5,157,268 tons in the previous year, while the output of coal in Natal fell from 2,567,817 tons to 2,303,116 tons as the direct result of the war interfering with the export and bunker coal trade. It is estimated that but for the war the Transvaal coal output this year would have reached six million tons, and Natal two million tons.

MINERAL EXPORTS.—The copper concentrate exported during 1915 from the Union of South Africa amounted to 28,875 tons, as against 29,325 tons for the previous year, but the value increased from £692,355 to £817,793. Tin concentrate increased from 3429 tons to 3435 tons and the value from £311,391 to £340,428. Asbestos increased from £20,087 to £35,979, graphite from £970 to £1204, magnesite from £1451 to £1568, lead from £1396 to £1836, zinc from nil to £9193, crude soda from £7196 to £20,949, and miscellaneous other minerals, principally antimony, from £144 to £5557.

TOKYO.

THE year 1915 was a prosperous one for the mining industry in Japan and there were several important changes. There was increased output in all lines. Copper continues to be the most important metal locally mined. The four leading mines, the Hitachi, Ashio, Kosaka, and Besshi each showed increases, and the four continue to stand in a class alone among Japanese mines. The Hitachi, belonging to the Kuhara interests, has got into full swing and probably has won first place in output. The Furukawa engineers, however, have not been idle and are always reducing costs and improving practice. Within the year the new dust chambers were put into service at the Ashio smelter. They are built of concrete in order to expose as little metal as possible to the fumes, and are constructed on the Great Falls plan of obstructing the flow of gases by hanging wires and other devices. When the gas first enters the chambers it is given a spiral motion, causing a large percentage of the dust to settle at once in a cone-shaped hopper. Four chimneys were built, but one was kept in reserve. The whole arrangement has given great satisfaction. [Details were printed in the *Mining and Scientific Press*, July 4, 1914.—EDITOR].

REINFORCED CONCRETE DUST CHAMBERS AT THE ASHIO SMELTER OF THE FURUKAWA MINING CO., JAPAN.

Probably the most important change in the smelting situation in Japan was the expansion of zinc smelting. Previous to 1915 only a small amount of spelter was made. The Mitsui Company, which, in the Kamioko and various other mines, possesses zinc ores, built in 1913 a small plant at Omuta on Kiushiu island. This is near the Manda colliery where cheap fuel and an excellent harbour is available, and where the company already had by-product coke ovens and other industries. The works have now expanded beyond the capacity of the local zinc mines, and the company has also bought Broken Hill ore, the company is importing ore from Siberia, where near Vladivostok there is an important property that before the war shipped to Germany. The Fujita company has also gone into zinc smelting. The great Kosaka copper mine, owned by the Fujita family, like many another copper property, has shown a considerable amount of zinc ore coming in, as the larger copper ore-bodies became exhausted. To treat this ore the Nippon Zinc Smelting Co. was organized and works were erected near Osaka. Taking advantage of the opportunity existing, the combination of concentrate and wool, and the presence of a Japanese shipping line permitting a low freight rate for imports. Takata & Co. have also in hand a small zinc smelter, so that the current output of spelter may be put at 3000 to 4000 tons per month. Many of the minor metals are also being mined to meet current needs. Tungsten, molybdenum, antimony, and tin are all being produced, the Mitsu Bishi Co. operating a tin smelter near Osaka. So keen is the search for antimony that the old dumps at the Ichinokawa mine, Shikoku, are being re-worked. The mine itself, the source of the famous stibnite crystals found in most mineral collections, has long been exhausted.

WESTERN AUSTRALIA.

THE FIREWOOD STRIKE.—The contracts for the supply of fuel between the firewood companies and the Kalgoorlie and Boulder mining companies, involving £27,000 per month, and the agreements between the former and the cutters expired on December 31 last. The men demanded an increase of sixpence a ton for cutting and a rise in wages work. This was refused by the firewood companies, and the cutters promptly went on strike. The mines were thus without their firewood supplies, and except at the Ivanhoe and Kalgurli, there was a general cessation of work. As soon as the strike started, the Minister for Mines went to Kalgoorlie and took an active part in arranging the compromise between the firewood companies and the cutters. At the outset the Minister suggested that he would be willing to supply the mines with wood from the State forest, and the cutters offered to cut wood on wages, but as neither of the schemes were practicable the Chamber of Mines would not entertain them.

In the contracts between the firewood and mining companies, it is provided that any increase given to the cutters must not be passed on to the mines unless such increase had been granted by the Arbitration Court. The Chamber of Mines rightly contend that as the mining companies have to abide by the decisions of that Court, which was created by the employees especially for their own protection, the employees should appeal to that tribunal for redress of their grievances instead of going on strike. However, the cutters were unwilling to do this, with the result that they were out of work for three weeks. At the end of that time a compromise was arranged by which they secured an increase of threepence per ton on the cutting rate and an adjustment of some wages claims.

The effect of the strike is that not only the woodcutters but also a much greater number of mine employees have lost at least twelve pounds per man. This loss is also felt by the Labour Unions, which even with this cessation had to provide over £1000 to meet the cost of food to some of their poorer members. But the shopkeepers feel the loss most, as during a strike they have little chance of taking any money.

It is therefore to be hoped, and there is every reason to believe, that wiser counsels will prevail when the present wages award for the Kalgoorlie and Boulder mines expires in April next. Hitherto the Chamber of Mines, under extreme pressure, has, at the expiration of the wages agreements, given the employees an increase of wages, and so disastrous strikes have been averted. Now owing to the higher cost of supplies caused by the war, to the loss in efficiency of labour due in part to the enlistment of the younger and better type of men, and to that ever present bugbear of the mine superintendent the constantly decreasing yield per ton, combine to make it imperative that the representatives of the employees should understand that any further increase in wages would necessitate at least the restriction of output of several of those mines which employ a large number of men, but return nothing to shareholders, and are under the present conditions just able to pay expenses.

MINERS' WAGES.—The Eastern Goldfields Miners' Union is a member of the Federal Union of Miners, and there is now a movement on foot to bring the surface workers under the jurisdiction of the Federal Arbitration Court. Mr. Justice Power, sitting at that Court, recently gave his award on the claims of the Victorian, New South Wales, and Tasmanian miners. He stated "I feel satisfied that the public, if asked to express its opinion, would hold that if an industry becomes so unproductive that it cannot pay a fair wage for a fair day's work, it should not be continued if the only way to continue it is by compelling the labourer to accept less than the value of his work." The result of this statement, coming as it does from a Judge of the High Court of Australia, instead of bringing the employers and employees together, will widen the breach, which is unfortunately far too great already.

WESTONIA.—In the Edna May mine the lode has been penetrated a distance of 10 ft. at the No. 4 level, where it assayed 120s. per ton. The pumps are now raising 1,200,000 gallons of water per day, but it is expected that this amount will diminish after the pumps have been in operation for a few weeks.

In the Edna May Deep Levels, the shaft has been sunk to a depth of 343 ft., and seems to be nearly through the fractured country. At present about 12,000 gallons of water per day are being hoisted with buckets. The manager estimated that the cost of sinking the shaft in the wet ground by means of the cement process would not exceed £25 per foot, and it is understood that this has been borne out. It is certainly cheaper than if the water had been baled. The confirmation or otherwise of the bore-hole results in this mine is being eagerly awaited by shareholders in both of the above mines, which are respectively gainer and loser of the lode.

CAMBORNE.

TIN SMELTERS' RETURNING CHARGES.—It is common knowledge that the mines generally are having a hard struggle to meet the increased operating cost due to war conditions, and the margin in many cases between profit and loss must be very small. It has for some years past been urged by the writer in this Magazine that the charges of the Cornish smelters were unreasonably high, but, although to his certain knowledge of late months it has had more attention, it is doubtful whether mine managers generally have been convinced on the point; otherwise, surely, before now some united demand would have been put forward for an alteration in the selling procedure. A returning charge of £10 per ton on a 70% concentrate, with the smelting works situated locally, would be regarded outside this county as very high indeed, but if Cornish mines selling their concentrate at the Ticketing only had to pay such a figure at the present time, it would, in some cases, convert their losses into profits, and in all cases would mean a substantial saving. The writer has not had the necessary time of late at his disposal to prepare detailed figures over a lengthened period, but probably those given below will be sufficient to convince the unbelievers. The Ticketng of February 28, 1916, has been taken, as the last held at the time of writing, and in the cases quoted, the assays for both moisture and tin have had to be estimated. However, readers who have knowledge of the produce of the mines in question can judge for themselves whether these estimates are reasonably near the truth or not. The results have been calculated as follows. To the weight of the crop concentrate ticketed has been added the draftage of 3 lb. per cwt.; these together being the total wet weight of concentrate delivered to the smelter. The moisture has then been calculated at 8% (the average is probably nearer 7%), and this deducted, gives the dry weight of the parcel. The sum actually realized at the Ticketing is given, and this sum, divided by the dry weight, gives the price actually received at the Ticketing per ton of dry concentrate. The assay of tin metal in each parcel is then estimated; the average price of cash and three months' tin metal prices on the Ticketing day (as taken from the Ticketing paper) is given, and the value of the concentrate calculated on the dry weight, estimated assay, and average price. The difference between the price per ton of concentrate dry weight actually received and that of its value as calculated, is the sum paid to the smelter, or in other words, is the returning charge.

From these figures it will be seen that it is calculated that Dolcoath paid on this parcel a returning charge of £15. 16s. 7d. per ton. If it is assumed that £10 is a reasonable returning charge, and that, therefore, on an average, say £5 per ton in excess of this figure has been paid, on Dolcoath's sale of approximately 1187 tons of concentrate for the year ended December 31 last, the saving would have been nearly £6000. The other cases quoted can easily be figured.

The writer fully appreciates the difficulty at the present time of an individual company negotiating a contract for the sale of its concentrate, but if the companies combined to demand a change in the present method of sale, no doubt the smelters would be forced to acquiesce in the abolishment of the Ticketing, and in the substitution of the contract method, which is the recognized method for the sale of tin concentrate in every other centre of the tin-mining industry. The establishment of a large smelting works in New York is a factor not to be forgotten.

DOLCOATH.—For the first time since the inception of the present company a loss on working has been made, and no doubt many shareholders on receipt of their report recalled Captain Arthur Thomas' remark some years

TABLE SHOWING SMELTERS' PROFITS ON CORNISH TIN ORES.

Mine	Weight (wet) of concentrate ticketed on Feb. 28, 1916	Draftage of 3 lb. (wet) per cwt. allowed to smelter by custom				Total wet weight delivered to smelter				Estimated moisture	Total dry weight delivered to smelter				Total realized at ticketing			Price realized per ton of concentrate (dry weight)			Estimated Assay (in metal)	Average of cash and three months tin metal prices on Ticketing date			Value of concentrate based on estimated assay and average price per ton (dry weight)			Returning charge, that is, difference between price per ton actually realized and its estimated value		
	Tons	Tons	Cwt.	Qr.	Lb.	Tons	Cwt.	Qr.	Lb.	%	Tons	Cwt.	Qr.	Lb.	£	s.	d.	£	s.	d.	%	£	s.	d.	£	s.	d.	£	s.	d.
Dolcoath	40	1	1	1	20	41	1	1	20	8	37	15	2	24	4400	2	6	116	9	0	72	186	10	0	132	5	7	15	16	7
East Pool & Agar	30		16	0	8	30	16	0	8	8	28	6	3	4	3093	15	0	109	3	3	68	186	10	0	126	16	5	15	13	2
Carn Brea & Tincroft	21		11	1	0	21	11	1	0	8	19	16	3	0	2203	15	0	111	1	8	70	186	10	0	130	11	0	19	9	4

ago to the effect that whatever the price of tin, Dolcoath always made a profit. However, conditions have changed since then; the mine is poorer, and the war has seriously affected working costs. The loss for the six months ended December 31 last was £4990, to which must be added depreciation written off amounting to £2497, or a total of £7487. The following figures are culled from the reports:

	6 months ended June 30, 1915.	6 months ended Dec. 31, 1915.
Tonnage milled	42,676	40,394
Black tin sold (tons)	679	508
Recovery per ton of ore milled (lb.)	35·60	28·17
Average price black tin	£96 2 8	£89 17 6
Average price per ton of ore milled	30s. 6·75d.	22s. 7·28d.
Working cost per ton (excluding depreciation)	27s. 4d.	25s. 9d.
Development footage	927	882
Ratio per ton of ore milled	1ft. to 46 tons	1 ft. to 46 tons

The main interest in the meeting was the declaration that the new owners of the Tehidy Estate were prepared to make a contribution toward the cost of certain development work, in the form of a remission of dues. It is proposed to deepen Stray Park shaft, drive the 440-fathom level therefrom and to communicate the 490-fathom level from Wheal Harriett. Captain Thomas has high hopes of finding good ore in this western section of Dolcoath, and certainly many local mining people have more faith in this exploratory work than in deeper sinking around Williams' shaft. The cost of this scheme in its entirety will be £35,000 to £40,000. Over 33% of the underground force have joined the Services, and this serious reduction in productive labour has, of course, materially affected the position. However, the higher price for tin and a small increase in the returns has enabled the mine to work without loss since the commencement of the year.

East Pool and Agar.—The report and accounts for 1915 have now been issued; the latter showing a loss of £942, after charging £1777 for depreciation. The figures given on the next column are of interest.

It will be noted that development has been by no means too vigorous in view of the large tonnage extracted; probably, however, the financial position has necessitated some curtailment.

When it is remembered that, even with the present high working cost and low recovery values, a small profit has been made (if depreciation is excluded), then it is not difficult to picture the possibilities opened up by the discovery in the Agar section, mentioned in last month's issue. The excitement caused locally by this find has been tremendous. In the street, in the trains, in the hotels, it has been the main topic of conversation, and this excitement has been fed in the local press by most highly coloured descriptions of what is termed a 'mining romance.' The active dealings in the shares has caused the price to rise from 6s. to 22s., and altogether the conditions locally are such as to remind one of the boom days of many years ago.

	1913	1914	1915
Tonnage milled	68,216	81,593	81,426
Recovery:			
Black Tin	529	644	597
Wolfram	45	108	127
Arsenic	239	456	805
Copper	20	20	15
Yield per ton (lb.):			
Black Tin	17·35	17·69	16·42
Wolfram	1·49	2·95	3·50
Arsenic	7·83	12·51	23·24
Copper	·65	·55	·43
Development footage	4187	3081	3627
Ratio to tonnage milled	1 ft. to 16 tons	1 ft. to 26 tons	1 ft. to 22 tons
Working cost per ton milled	20s. 6d.	17s. 3d.	21s.

Carn Brea & Tincroft.—In such times as these, a profit of £1290, excluding depreciation of £681, for the six months ended December 31 last, must be regarded as satisfactory, particularly seeing that no profit previously had been earned for three years. The tonnage crushed was 29,795 tons (slightly in excess of the previous six months), the black tin produced 299 tons, which equals a recovery of 22·46 lb. per ton, the value being 17s. 10·45d. per ton. The total receipts (including arsenic £4541 and wolfram £3464) were 24s. 0·87d., and the working cost (excluding depreciation), 23s. 2·47d. per ton. The development was 951 feet, or one foot for each 31 tons milled. From the speeches at the shareholders' meeting, it would appear that the prospects of the mine are distinctly encouraging, and Captain W. Thomas is to be heartily congratulated on his handling of a difficult problem. At the meeting, reference was made to the fact that although the shareholders had received no interest on their capital for many years, the mine had been of direct benefit to the district, including the merchants, property owners, employees, etc. The 'lord' (Viscount Clifden) has not benefited very materially of late years, inasmuch as he has re-invested £20,000 in the mine. However, from the figures presented in another column, it would appear that the smelters should be included in those who have done well out of the property.

PERSONAL.

J. A. AGNEW has returned to London after a visit to the Camp Bird mine in Colorado, and the Santa Gertrudis mine at Pachuca, Mexico.

H. FOSTER BAIN was in Cornwall last week.

SYDNEY H. BALL has returned to New York from Missouri.

JOHN M. BECKWITH has left London for Mundoo Island, Goolwa, South Australia.

G. T. BEILBY is President-Elect of the Institute of Metals.

S. W. BELL is at present manager of a government high explosives factory.

C. W. BOISE was in London on his way from Congo Belge to America.

R. S. BOTSFORD has left Petrograd for Eastern Siberia, in connection with dredging operations for the Lena Goldfields.

W. H. BRAGG is to deliver the annual May lecture of the Institute of Metals, and will discourse on 'X-Rays and Crystal Structure, with Special Reference to Certain Metals.'

HENRY BRELICK is on his way home to England from the Argentine.

SPENCER C. BROWNE is geological engineer for the Midvale Steel Company.

W. T. BURNS has been appointed superintendent of the electrolytic copper refinery and electrolytic zinc plant at Great Falls, Montana.

ARTHUR A. COLE has been nominated for the presidency of the Canadian Mining Institute.

EDGAR A. COLLINS is resigning as manager of the Commonwealth mine, Arizona.

J. H. CROSBY, for many years a director of companies operating mines on the Rand controlled by Sir J. B. Robinson, and latterly vice-chairman, severed his connection at the end of January.

DONALD DOYLE is here from the Congo.

C. M. FISHER has returned to the United States.

R. M. GEPPERT has been visiting the Esperanza mine, El Oro.

HARRY D. GRIFFITHS has left London on a visit to Burma and the Malay Peninsula.

RICHARD HAMILTON, manager of the Great Boulder mine, has been appointed the Chamber of Mines representative on the West Australian War Council.

ALFRED HARKER has been elected president of the Geological Society of London.

FRED. HELLMANN, manager of the Chuquicamata mine, Chile, is in New York.

W. M. HENDERSON-SCOTT, Captain in the Queen's Westminster Rifles, and Assistant Provost Marshal with the British Expeditionary Force, was married on February 15 to Marjorie de Paiva.

PHILIP HENRY has been appointed mining engineer for the International Corporation.

LOFTUS HILLS, one of the Government Geologists for Tasmania, has volunteered for the Australian Mining Corps.

ALLEN C. HOWARD, a member of Minerals Separation staff, is in command of a Royal Engineer Field Company in Flanders, holding the rank of major.

V. H. HUGHES has been examining oil properties in Mexico, and has returned to Oklahoma.

E. HORTON JONES, formerly chief engineer to the Arizona Copper Company, has left for Copper Cliff, Ontario, to take a position with the Canadian Copper Company.

A. P. KARPINSKY has been awarded the Wollaston medal of the Geological Society, in recognition of his excellent work in connection with the geological survey of Russia. To many of our readers he is well known as an authority on the geology of the Ural region.

W. J. KING has returned from Northern Nigeria.

DAVID H. LADD, lately metallurgist at Wallaroo, Australia, has been appointed general manager of the Sandusky Foundry, Ohio.

P. G. LIDNER has gone from New York to Hayti, where he expects to remain for three months.

G. MACFARLANE has returned from Burma.

W. W. MEIN and KARL HOFFMANN arrived from New York last week.

F. P. MENNELL has been giving evidence for the plaintiffs in the case of the Amalgamated Properties of Rhodesia versus the Globe & Phœnix.

WILLET G. MILLER is in London in connection with the work of the Ontario Nickel Commission.

THOMAS N. MILLER has resigned from the staff of the Oriental Consolidated in Korea, and will go to the Philippine Islands.

J. C. MOULDEN, manager for the Central Zinc Co. at Seaton Carew, Durham, has been awarded the Peter Le Neve Foster prize by the Royal Society of Arts for an essay on 'Zinc, its Production and Industrial Applications.' ERNEST A. SMITH, of the Sheffield Assay Office, received honourable mention for his essay.

C. A. MOREING attended the East Pool meeting last week, and visited properties in Cornwall managed by Bewick, Moreing & Co.

H. E. NICHOLLS has become associated with Lake & Currie, and his address will be with that firm at Norfolk House, Laurence Pountney Hill, London, E.C.

EDGAR PAM, manager of the Geldenhuis Deep, has arrived in England to join the Royal Engineers.

H. C. PARMELEE has been elected president of the Colorado Scientific Society.

JOSIAH PAULL is manager of the South Crofty mine near Camborne.

WALTER G. PERKINS has transferred his headquarters from London to Petrograd.

E. F. PITTMAN is retiring from the position of Government Geologist and Under Secretary of Mines for Queensland, and is succeeded by R. H. Cambage.

EDGAR RICKARD has been in San Francisco.

W. A. ROGERS, the retiring president of the Geological Society of South Africa, gave as his valedictory address a lecture on the copper deposits of Little Namaqualand.

T. SKEWES SAUNDERS, manager of the Dos Estrellas, El Oro, Mexico, has paid a short visit to the head office of the company in Paris, and has returned to Mexico by way of London.

WILLIAM SELKIRK, who was operated upon for appendicitis, is recovering.

NORMAN STINES is in London.

J. W. H. STUBBS has arrived in England from the Rand.

G. GORDON THOMAS is here from Northern Nigeria.

PERCY A. WAGNER has been elected president of the Geological Society of South Africa.

F. WARTENWEILER has left Prestea and has returned to Johannesburg.

D'ARCY WEATHERBE sailed on the *Adriatic* for New York on his way to Cobalt, Ontario. He is expected back in London toward the end of this month.

R. F. J. WEEKS, metallurgist to the Champion Reef Gold Mining Co. of India, is with the Royal Engineers, and has been promoted to the rank of Captain.

CHARLES WILL WRIGHT is at Geneva, Switzerland.

METAL MARKETS

COPPER.—A further spectacular rise in price carried standard copper up to £109 about the middle of February. This proved the high water mark, and the tide of prices has been receding ever since. The change in sentiment has been accelerated by Government action, in firstly fixing a maximum price for iron, and secondly in suspending dealings in copper, lead, iron, and spelter until further notice. The regulation prohibiting dealings was soon modified, as such a drastic measure would only aggravate the evil which it was intended to relieve. But the knowledge that the Government is sincere in its determination to regulate prices has had a steadying effect on the market, and there is every evidence that dealers are loyally co-operating to give effect to the Government's wishes. The month of February closed with standard at £101 for cash, and £99 for three months. The business put through has been small. At the present level buyers naturally show a disinclination to buy for more than their immediate needs. The difficulty of shipping is also limiting the volume of transactions. On the other hand orders have been given out by the United States Government on its own behalf for munitions. While the situation there is quieter, prices show very little modification, the latest quotations for electrolytic being 26¾ cents to 27¼ cents for forward delivery. In this country £135 to £137 is asked. The outlook appears to be for steadier markets in the near future.

Average prices for cash standard copper: February 1916, £102 13s. 1d.; January 1916, £88. 2s. 11d.; February 1915, £63. 12s. 6d.

Sulphate of copper is quoted at £48 per ton, though little can be obtained at this price. Copper tubes are quoted at 18½d. per lb., copper wire at 18d. per lb., yellow metal 18d. per lb., tough copper £126 per ton, rods £148, sheets £148. Brass sheets 17d. per lb., wire 16½d., drawn tubes 17d., brazed tubes 19d.

TIN.—Prices kept quietly steady round £180 until late in February when prominent operators came to the support of the market, and values rose rapidly until £189 three months was reached. The market then reacted to £183. 10s. cash and £183. 15s. three months, following on the publication of the regulations as to dealings in other metals. Shipments from Java have been difficult owing to lack of steamer space, and as permits for export are being only sparingly granted both in Java and in the Straits prices show wide local differences. In New York 50c. or £235 has been realized for spot. Consumption over there is larger than ever, and the heavy premium on spot indicates that there is no surplus. America will have to continue to purchase heavily not only to meet current demand but also to accumulate stock. Russia has bought important lines for shipment to Vladivostok. Home demand is rather dull, tin-plate mills having to go slow through the continued difficulty in getting steel and acid. The market looks like keeping firm.

Average prices of cash standard tin: February 1916, £181. 3s. 4d.; January 1916, £175. 16s. 4d.; February 1915, £177. 1s. 9d.

SPELTER.—There has been a sharp advance in prices, and the official quotation is now £110 to £95. America is firm and supplies on this side are small. American producers are believed to have heavy stocks, but in view of the demand they are able to hold for high prices. The congestion on the American railways, combined with the difficulty of finding freight room, is causing great delay in effecting deliveries to contract time. The policy of buyers to buy from hand to mouth is leaving them at the mercy of smelters.

Average prices of good ordinary brands: February, 1916, £93. 10s. 11d.; January 1916, £83. 12s. 5d.; February 1915, £39. 16s. 5d.

LEAD.—This market has been firm. Fortunately the freight situation was relieved, and with supplies coming into London more freely prices have been prevented from getting out of hand. Anxiety as to the future, however, still exists, for the shipments from Spain are likely to be limited owing to the demands from Italy, France, and Russia. America has little surplus for disposal, and the latest quotation from there is 6·40 cents. The London price shows a rise of £2 at £32. 17s. 6d. for cash, and £33. 5s. for forward. The heavy premium for spot metal has fortunately disappeared. The Government action is scarcely likely to affect values of the metal in face of the scarcity and the demand, and consumers are having to pay a good deal above official quotations for their supplies.

Average prices of good soft foreign lead: February 1916, £31. 18s. 9d.; January 1916, £30. 17s. 5d.; February 1915, £19. 3s. 7d.

ANTIMONY.—The quotation for antimony continues to be nominal, and probably transactions are effected at about £120 per ton. The quotation for ore is 10s. per unit. The development of the Chinese resources is being pushed. In this connection the paper by A. S. Wheler noted in another part of the Magazine will be of interest. The Bolivian deposits might be made to supply larger quantities than at present.

QUICKSILVER.—The price of Spanish quicksilver is unaltered at £16. 10s. per flask of 75 lb. In America the supply is scarce, and the price is much inflated, as much as £60 per flask being paid.

BISMUTH.—10s. per lb.

COBALT.—96 to 98%, 8s. per lb.

CADMIUM.—7s. 6d. per lb.

PLATINUM.—As the Government now has control of supplies of this metal none can be bought in the market. Johnson, Matthey & Co., acting as purchasing agents for the Government, offer 190s. per oz. In America supplies are scarce, and the quotation is nominally around £20 per oz.

ALUMINIUM.—This metal is now under Government control, and purchases can only be made by consent. No quotation is possible, though £160 may be mentioned as a likely price. The American market is stronger than a month ago, with a greater demand, and quotations are about £250 per ton. By a regrettable misprint, last month's American quotation was given as £125 instead of £225.

MANGANESE.—The quotation for Indian 50% ore is about 2s. 8d. per unit and for Brazilian 4s. per unit, both delivered in this country. The price of ferro-manganese has been raised from £20 to £25 per ton. In America the scarcity of ferro-manganese is causing inconvenience in some quarters, and as much as £50 per ton is being paid. Metallic manganese, 90 to 95%, free from carbon, 2s. 8d. per lb.

NICKEL.—The quotation remains at £220 per ton. Negotiations are proceeding in connection with the refining of Canadian nickel locally, and Dr. Willet G. Miller, representing the Ontario Nickel Commission, is in London at present.

CHROMIUM.—The quotations for chrome ores are now given in a different form, those for New Caledonia and Baluchistan ores being for delivery at the port of export and those for Rhodesia for delivery in London: New Caledonia 53 to 55%, basis price for 50% Cr_2O_3, 36s. per ton f.o.b., scale 2s. per ton. Rhodesia ore 48 to 52%, basis price for 48% Cr_2O_3, 132s. 6d. per ton c.i.f. London, scale 2s. per ton. Rhodesia ore 47%, 125s. per ton flat c.i.f. London. Baluchistan ore 53 to 55%, basis price for 50% Cr_2O_3, 36s. per ton f.o.b., scale 2s. per ton. Ferro-chrome 8 to 10% carbon, £32. 10s. per ton, basis 60%, scale 10s. per unit; 6 to 8% carbon. £33. 15s. per ton.

MOLYBDENUM.—The price of molybdenite remains at 100s. per unit averaging 90% MoS_2. Conditions are very different in the United States owing to lack of applications, and *The Engineering and Mining Journal* quotes the price at only 6s. per unit. Ferro-molybdenum 65 to 85% Mo, 18s. per lb.

TUNGSTEN.—The official quotation for wolfram and scheelite remains at 55s. per unit. In America as many dollars per unit are being paid. Ferro-tungsten 80 to 90%, low carbon, 5s. 8d. per lb.; tungsten metal powder 96 to 98%, 5s. 10d. per lb.

TITANIUM.—Ferro-titanium 15 to 18% Ti and 5 to 8% C., 6½d. per lb.; 23 to 25% Ti, free from carbon, 1s. 9d. per lb.

VANADIUM.—Ferro-vanadium, 14s. 6d. per lb. of vanadium contained.

FERRO-SILICON.—Basis 75% Si, £48 per ton, scale 8s. per unit.

IRON.—The Government interdiction of speculation in the metal markets and the fixing of an official maximum for Cleveland No. 3 pig iron have had a wholesome effect on the iron market, and prices have been steadied. No. 3 had passed the 90s. mark, but has now receded to 86s. per ton, as compared with 88s. 6d. a month ago and 51s. 6d. before the war. Bessemer pig is quoted at 127s. 6d., showing no alteration on the month, and Staffordshire iron is at 170s. Spanish hematite ore has risen to 42s. 6d. delivered.

SILVER.—The market during the past month has presented no feature of interest and the quotation has varied from day to day between 26¾d. and 27¼d. per oz.

SPECULATION IN METALS.—The following is the Official Order suppressing speculation in metals:

It shall not be lawful for any person on his own behalf or on behalf of any other person to sell or buy, or to offer to sell or buy:

(a) Any of the following metals: Iron (including pig iron), steel of all kinds, copper, zinc, brass, lead, antimony, nickel, tungsten, molybdenum, ferro-alloys; or

(b) Any other metal which may be specified in an order of the Admiralty or Army Council or the Minister of Munitions as being a metal required for the production of any war material, unless in the case of a seller the metal to be sold is in the possession of the seller or is in the course of production for him, or in the case of a buyer the purchase is made for or on behalf of a consumer; and it shall be lawful for the Admiralty or Army Council or the Minister of Munitions, or any person authorized by them or him for the purpose, to require any person who, on his own behalf or on behalf of any other person, has sold or bought, or offered to sell or buy any such metals, to prove that the sale or purchase complies with the requirements of this regulation, and if any such person on being so required fails to produce satisfactory proof that it does so comply he shall be guilty of an offence against these regulations, and if such person is a company every director and officer of the company shall also be guilty of an offence against these regulations:

Provided that it shall be lawful for the Admiralty or Army Council or the Minister of Munitions by order to exclude from the provisions of this regulation any of the metals above mentioned, and whilst any such order remains in force this regulation shall have effect as if such metal were not mentioned therein.

PRICES OF CHEMICALS. March 9.

		£	s.	d.
Acetic Acid, 40%	per cwt.	2	7	0
,, 60%	,,	4	10	0
,, Glacial	,,	8	15	0
Alum	per ton	10	0	0
Alumina, Sulphate of	,,	14	0	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	32	0	0
,, Chloride of, grey	per cwt.	1	12	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	75	0	0
,, Phosphate of	,,	75	0	0
,, Sulphate of	,,	17	0	0
Arsenic, White	,,	29	0	0
Barium Chloride	,,	28	0	0
,, Carbonate	,,	5	0	0
,, Sulphate	,,	5	10	0
Bisulphide of Carbon	,,	30	0	0
Bleaching Powder, 35% Cl.	,,	16	10	0
Borax	,,	28	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	2	0	0
Copper, Sulphate of	,,	49	0	0
Creosote	per gal.		0	4
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			5
Iodine	,,		13	9
Iron, Sulphate of	per ton	3	5	0
Lead, Acetate of, white	,,	100	0	0
,, Chemical Sheet Metal	,,	39	0	0
,, Nitrate of	,,	80	0	0
,, Oxide of, Litharge	,,	40	0	0
,, White	,,	40	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	14	10	0
Oxalic Acid	per lb.		1	5
Phosphoric Acid	,,			10
Potassium Bichromate	,,		1	6
,, Carbonate	per ton	180	0	0
,, Chlorate	per lb.		1	8
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb		7	6
,, Prussiate, Yellow (Ferricyanide)	,,		4	3
,, Sulphate, 90%	per ton	55	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	60	0	0
,, Bicarbonate	,,	6	10	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	10	0
,, Hydrate, 76%	,,	17	10	0
,, Hyposulphite	,,	17	0	0
,, Nitrate, 95%	,,	16	10	0
,, Phosphate	,,	27	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	12	6
,, Sulphide	,,	26	0	0
Sulphur, Roll	,,	13	0	0
,, Flowers	,,	13	0	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tartaric Acid	per lb.		2	8
Tin Chloride (Tin Crystals)	,,		1	2
Zinc Chloride, solution 100°T.	per ton	32	10	0
Zinc Sulphate	,,	33	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3,202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,243,347
June	727,924	27,356	755,280	3,208,224
July	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122
November	753,605	27,408	781,013	3,317,534
December	755,101	26,010	781,111	3,317,949
Year 1915	8,772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9 468	970	219,864

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846
May	2,416,966	25 8	17 0	8 6	1,031,220
June	2,346,493	26 1	17 2	8 8	1,017,908
July	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229
December	2,410,841	26 5	17 10	8 2	985,361
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	—	144,034	—
March	299,686	—	153,770	—
April	315,541	—	149,978	—
May	318,898	—	142,123	—
June	322,473	—	135,289	—
July	336,565	—	140,290	—
August	344,493	—	139,364	—
September	321,085	—	135,744	—
October	339,967	—	141,771	—
November	313,160	—	122,138	—
December	331,376	—	158,323	—
Total	3,823,166	318,586	1,706,473	140,579

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
July 1915	555	98,859	98,757	419,495
August	1,079	99,941	104,258	442,900
September	2,019	100,833	93,764	398,282
October	2,346	100,238	102 609	435,853
November	797	99,206	103,670	440,360
December	2,883	96,997	101,309	430,333
Year 1915	17,277	1,192,790	1,210,067	5,140,189
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,138	67,970	288,717

Production of Gold in Victoria and Queensland.

	Victoria.		Queensland.	
	1915	1916	1915	1916
	£	£	£	£
January	69,900	89,900	43,770	66,700
February	122,300	—	85,850	—
March	142,800	—	98,550	—
April	109,300	—	97,320	—
May	102,900	—	130,470	—
June	134,200	—	90,500	—
July	154,800	—	88,830	—
August	80,300	—	93,050	—
September	138,900	—	79,470	—
October	111,700	—	91,800	—
November	115,300	—	77,780	—
December	115,400	—	81,170	—
Total	1,397,800	89,900	1,078,560	66,700

Production of Gold in India.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	—
April	191,215	189,197	196,747	—
May	190,607	193,031	199,786	—
June	189,322	192,224	197,447	—
July	193,859	195,137	197,056	—
August	193,998	196,560	197,984	—
September	191,642	195,843	195,952	—
October	194,314	198,191	195,531	—
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	375,414

Daily London Metal Prices in £ per long ton.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard
Feb.	£	£	£	£	£
1	$94\frac{5}{8}$	124	$31\frac{3}{4}$	90	$179\frac{7}{8}$
2	$94\frac{5}{8}$	$125\frac{1}{2}$	$31\frac{3}{8}$	90	$178\frac{7}{8}$
3	$94\frac{7}{8}$	127	31	88	$178\frac{3}{8}$
4	$95\frac{7}{8}$	128	31	89	180
7	$97\frac{5}{8}$	129	$31\frac{1}{4}$	89	180
8	$101\frac{1}{2}$	131	32	89	$179\frac{1}{2}$
9	100	132	$31\frac{3}{4}$	91	$179\frac{3}{4}$
10	104	134	32	92	$179\frac{5}{8}$
11	$103\frac{3}{8}$	134	$32\frac{1}{8}$	93	$179\frac{7}{8}$
14	$105\frac{7}{8}$	$135\frac{1}{2}$	$32\frac{1}{8}$	93	$180\frac{7}{8}$
15	$106\frac{3}{8}$	$136\frac{1}{2}$	$32\frac{1}{4}$	99	$182\frac{3}{8}$
16	$104\frac{3}{8}$	$136\frac{1}{2}$	$32\frac{1}{8}$	100	$182\frac{1}{8}$
17	$106\frac{1}{2}$	$136\frac{1}{2}$	32	102	$180\frac{7}{8}$
18	$107\frac{7}{8}$	$137\frac{1}{2}$	32	103	$179\frac{7}{8}$
21	$108\frac{1}{8}$	136	32	103	$180\frac{1}{8}$
22	$107\frac{1}{8}$	136	32	105	$180\frac{1}{8}$
23	$106\frac{3}{8}$	136	$32\frac{1}{4}$	105	$181\frac{3}{8}$
24	$103\frac{3}{8}$	136	$32\frac{1}{4}$	105	$181\frac{7}{8}$
25	$102\frac{1}{2}$	136	$32\frac{3}{8}$	108	$184\frac{1}{4}$
28	$104\frac{7}{8}$	136	$32\frac{7}{8}$	108	$186\frac{3}{8}$
29	$105\frac{5}{8}$	136	$33\frac{1}{8}$	110	$188\frac{1}{8}$
Mar.					
1	$101\frac{1}{4}$	136	$32\frac{7}{8}$	110	$188\frac{1}{8}$
7	$100\frac{7}{8}$	136	$31\frac{7}{8}$	110	$187\frac{1}{8}$
8	$95\frac{7}{8}$	136	32	98	$187\frac{1}{8}$
9	$97\frac{3}{4}$	136	$32\frac{7}{8}$	95	$188\frac{1}{8}$
10	$102\frac{3}{4}$	136	$33\frac{1}{2}$	93	$189\frac{3}{8}$

No quotations from March 1 to 7 owing to Government decree against speculation in metals.

IMPORTS OF ORES AND METALS INTO UNITED KINGDOM.
Long tons.

	Year 1915	Jan. 1916	Feb. 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	4,111	3,928	8,039
,, Matte and Precipitate	38,372	4,893	1,793	6,686
,, Metal (unwrought and part wrought)	180,368	12,679	9,906	22,585
Copper and Iron Pyrite	903,401	2,862	79,081	180,971
Tin Concentrate	44,748	101,890	1,899	3,973
,, Metal	38,896	2,074	938	3,800
Manganese Ore	377,324	32,111	24,511	56,622
Lead, Pig and Sheet	256,476	12,167	19,490	31,657
Zinc (spelter)	74,520	2,852	3,771	6,623
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	382,690	376,600	759,290

STOCKS OF COPPER.
Reported by Henry R. Merton & Co. Ld. Long tons.

	Dec. 31, 1915	Jan. 31, 1916	Feb. 29, 1916
	Tons	Tons	Tons
Standard Copper in England	9,358	7,178	4,127
Fine Copper in England	1,763	1,573	734
,, ,, Havre	1,220	1,247	4,950
,, ,, Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*
,, ,, Afloat from Chile	3,600	3,525	2,300
,, ,, ,, from Australia	4,000	4,000	4,500
Total Visible Supply	25,064	22,646	21,734
In other European Ports Estimated	500*	500*	500*

* As on July 31, 1914, but presumably present stock nil.

EXPORTS OF COPPER FROM UNITED STATES
Reported by United States Customs.

1915	Long tons	1915	Long tons	1916	Long tons
January	28,197	July	16,812	January	21,863
February	12,066	August	16,289	February	20,548
March	29,725	September	14,327	March	—
April	20,481	October	26,153	April	—
May	25,785	November	19,396	May	—
June	15,751	December	32,936	June	—
		Total 1915	257,915	Total 1916	42,411

STOCKS OF TIN.
Reported by A. Strauss & Co. Long tons.

	Dec. 31, 1915	Jan. 31, 1916	Feb. 29, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	1,042	836	747
Ditto, Landing and in Transit	1,179	329	227
Other Standard, Spot and Landing	1,682	1,940	1,607
Straits, Afloat	1,077	1,765	4,330
Australian, Afloat	301	365	315
Banca, on Warrants	—	—	—
Ditto, Afloat	1,389	756	1,540
Billiton, Spot	—	—	17
Ditto, Afloat	50	335	417
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,719*	1,105*	1,850*
Afloat for United States	7,195	7,637	5,808
Stock in America	1,371	2,401	1,308
Total Stock	17,005	17,468	18,166

* Including 705 tons on board enemy's ships either captured or lying in neutral ports.

SHIPMENTS AND IMPORTS OF TIN
Reported by A. Strauss & Co. Long tons.

	Year 1915	Jan. 1916	Feb. 1916	1915 to date.
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	1,540	3,015	4,555
Straits to America	31,565	4,205	2,090	6,295
Straits to Continent	11,024	350	1,145	1,495
Australia to U.K.	2,481	324	316	640
U.K., Holland, and Continent to America	14,967	1,352	323	1,675
Imports of China Tin into U.K. and America	3,012	65	85	150
Imports of Bolivian Tin into Europe	22,591	866	640	1,506

NIGERIAN TIN PRODUCTION.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	—
March	247	510	502	418	—
April	141	430	482	444	—
May	144	360	480	357	—
June	121	321	460	373	—
July	140	357	432	455	—
August	201	406	228	438	—
September	196	422	289	442	—
October	256	480	272	511	—
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	531

PRODUCTION OF TIN IN FEDERATED MALAY STATES.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3,313
March	3,196	3,562	3,839	3,653	—
April	3,904	4,066	4,087	3,619	—
May	4,277	4,319	4,135	3,823	—
June	3,472	3,993	4,303	4,048	—
July	4,234	4,245	4,582	3,544	—
August	4,454	4,620	3,591	4,046	—
September	4,115	4,379	3,623	3,932	—
October	3,905	4,409	3,908	3,797	—
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46,767	7,629

SALE OF TIN CONCENTRATE AT REDRUTH TICKETINGS.

	Long tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
July 5, 1915	202	£18,721	£92 13 5
July 19	204½	£18,102	£88 10 5
August 3	177	£15,069	£85 2 9
August 16	171	£14,098	£82 9 0
August 30	156	£12,935	£82 18 5
September 13	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3
October 11	166	£13,620	£82 1 0
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0
December 20	181½	£16,941	£93 6 10
Total, 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18,122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179½	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	Mar. 1 1915	Feb. 1 1916	Mar. 1 1916
RAND:			
Bantjes	10	9	12
Brakpan	49	81	75
Central Mining (£12)	119	131	120
Cinderella	4	6	6
City & Suburban (£4)	44	40	35
City Deep	55	78	74
Consolidated Gold Fields	27	30	27
Consolidated Langlaagte	31	37	31
Consolidated Main Reef	17	20	20
Crown Mines (10s.)	82	64	56
D. Roodepoort Deep	15	15	15
East Rand Proprietary	29	21	17
Ferreira Deep	44	35	34
Geduld	22	37	35
Geldenhuis Deep	22	22	21
Gov't Gold Mining Areas	18	31	31
Heriot	60	47	50
Jupiter	4	7	7
Kleinfontein	21	30	28
Knight Central	6	14	17
Knight's Deep	20	25	22
Langlaagte Estates	18	20	18
Luipaard's Vlei	7	9	9
Main Reef West	6	9	9
Meyer & Charlton	101	120	106
Modderfontein B	88	122	110
Modder Deep	65	120	111
Modderfontein, New (£4)	254	324	301
Nourse	21	17	15
Rand Mines (5s.)	88	84	75
Randfontein Central	12	10	10
Robinson (£5)	31	26	20
Robinson Deep	26	22	20
Rose Deep	35	30	26
Simmer & Jack	8	10	7
Simmer Deep	1	3	3
Springs	16	41	48
Van Ryn	59	46	40
Van Ryn Deep	45	62	59
Village Deep	35	40	34
Village Main Reef	30	20	21
Witwatersrand (Knight's)	37	60	56
Witwatersrand Deep	39	26	24
Wolhuter	13	10	10
RHODESIA:			
Cam & Motor	16	13	11
Chartered	11	11	10
Eileen Alannah	10	10	9
Eldorado	14	11	9
Enterprise	4	5	4
Falcon	11	9	9
Giant	7	6	6
Globe & Phœnix (5s.)	31	26	20
Lonely Reef	26	24	23
Shamva	36	36	34
Wanderer (5s.)	2	1	1
Willoughby's (10s.)	5	5	5
OTHERS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	199	222	220
Glynn's Lydenburg	11	10	10
Jagersfontein	52	62	65
Premier Diamond Defer'd (2s. 6d.)	75	120	92
Sheba (5s.)	3	2	2
Transvaal Gold Mining Estates	37	25	23
WEST AFRICA:			
Abbontiakoon (10s.)	9	8	8
Abosso	7	10	10
Ashanti (4s.)	15	19	19
Broomassie (10s.)	2	½	½
Prestea Block A	12	8	8
Taquah	14	17	19
WEST AUSTRALIA:			
Associated Gold Mines	5	5	5
Associated Northern Blocks	5	5	4
Bullfinch	6	5	5
Golden Horse-Shoe (£5)	50	37	40
Great Boulder Proprietary (2s.)	17	15	15
Great Boulder Perseverance	2	1	1
Great Fingall	5	2	2
Ivanhoe (£5)	46	44	44
Kalgurli	37	15	14
Sons of Gwalia	21	15	15
Yuanmi	2	2	2

GOLD, SILVER, *cont.*	Mar. 1 1915	Feb. 1 1916	Mar. 1 1916
OTHERS IN AUSTRALASIA:			
Blackwater	15	15	15
Consolidated Gold Fields of N.Z.	11	11	11
Mount Boppy	11	14	15
Mount Morgan	46	38	44
Progress	5	5	5
Talisman	30	15	15
Waihi	41	35	35
Waihi Grand Junction	24	19	19
AMERICA:			
Alaska Treadwell (£5)	140	142	130
Buena Tierra	14	14	14
Butters Salvador	10	12	12
Camp Bird	7	7	7
Canadian Mining	9	11	10
Casey Cobalt	6	5	4
El Oro	9	9	8
Esperanza	10	10	10
Frontino & Bolivia	—	9	9
Kirkland Lake Proprietary	34	20	20
Mexico Mines of El Oro	82	77	74
Oroville Dredging	12	14	13
St. John del Rey	15	15	15
Santa Gertrudis	11	10	10
Tomboy	23	22	21
Tough-Oakes	13	12	12
RUSSIA:			
Lena Goldfields	31	29	35
Orsk Priority	—	15	15
INDIA:			
Champion Reef (2s. 6d.)	11	8	8
Mysore (10s.)	85	80	82
Nundydroog (10s.)	25	26	27
Ooregum (10s.)	25	24	24
COPPER:			
Anaconda (£10)	104	350*	360*
Cape Copper (£2)	55	50	62
Chillagoe (10s.)	½	½	½
Cordoba (5s.)	3	3	4
Great Cobar (£5)	3	2	4
Hampden Cloncurry	24	33	41
Kyshtim	44	35	39
Messina (5s.)	12	11	11
Mount Elliott (£5)	71	50	60
Mount Lyell	23	26	28
Rio Tinto (£5)	1165	1135	1205
Sissert	22	20	21
South American Copper (2s.)	12	14	15
Spassky	40	36	40
Tanalyk	46	34	35
Tanganyika	29	33	39
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	20	28	29
British Broken Hill	25	23	25
Broken Hill Proprietary (8s.)	37	48	59
Broken Hill Block 10 (£10)	24	17	15
Broken Hill North	42	44	49
Broken Hill South	140	135	154
Sulphide Corporation (15s.)	17	21	22
Zinc Corporation (10s.)	14	13	14
ASIA:			
Burma Corporation	31	33	36
Irtysh Corporation	—	34	35
Russian Mining	18	15	13
Russo-Asiatic	80	97	95
TIN:			
NIGERIA:			
Bisichi	7	6	6
Ex-Lands Nigeria (2s.)	1	1½	1½
Mongu	—	9	9
Naraguta	17	15	17
N. Nigeria Bauchi (10s.)	1	1½	2
Rayfield	4	4	4
Ropp (4s.)	17	14	14
OTHER COUNTRIES:			
Aramayo Francke	27	27	26
Briseis	5	5	5
Cornwall Tailings	12	5	5
Dolcoath	8	6	7
East Pool	11	11	17
Gopeng	27	29	31
Pahang Consolidated (5s.)	6	8	9
Renong Dredging	22	31	29
South Crofty (5s.)	6	9	8
Tekka	55	52	54
Tronoh	30	32	34

* Denomination of shares recently changed from £5 to £10.

THE MINING DIGEST

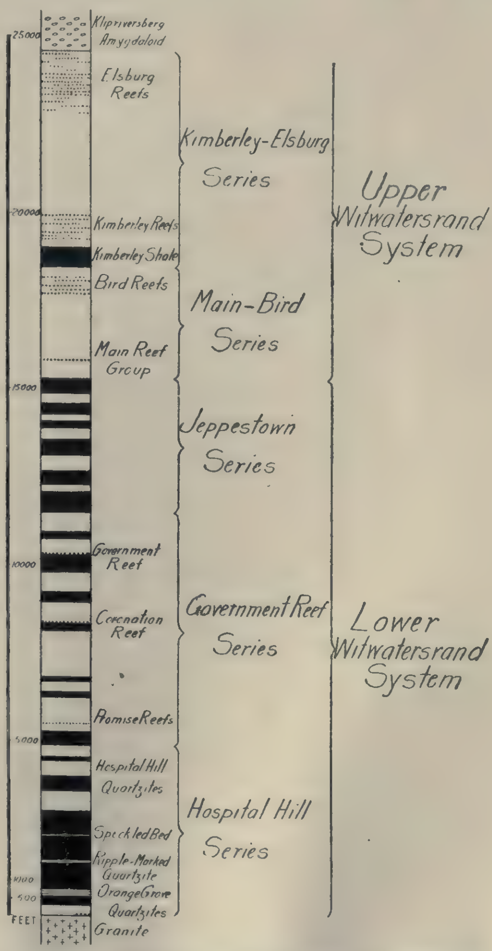
A PRECIS OF MINING TECHNOLOGY, DEVELOPMENT, AND LITERATURE

[In this department will be found listed the more important articles and miscellaneous publications appearing each month which deal with metal mining and non-ferrous mineralogy, the more significant publications being abstracted or reviewed. Copies of the originals can be obtained through the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.]

CONGLOMERATES OF THE WITWATERSRAND.

It may be accepted without challenge that no other geologist has had the opportunities enjoyed by Dr. E. T. Mellor for studying the structure and characteristics of the Rand gold deposits. For some years he has been engaged on the official geological survey of the Rand. The whole of this work has been in his hands, for funds were not available for a large staff. The apparent disadvantage of a limited government vote is far more than counterbalanced by the fact that Dr. Mellor has been able personally to inspect every mine, and to study for himself all the criteria bearing on the origin of the gold and the probable future of the mining industry. It was our faith in his competence to use his unparalleled opportunities that prompted us to quote him at considerable length in our issues of November and December last. For the same reason we welcome the reading of his paper before the Institution of Mining and Metallurgy on February 24. In this paper he devotes chief attention to a consideration of the arguments relating to the placer and infiltration theories of the origin of the gold. As we have already recorded, he holds that the gold was primarily deposited in a delta and that, after the conglomerates were formed and consolidated, it was subsequently dissolved by solutions, to be redeposited not far away. The present paper consists of an elaboration of his arguments. It is divided into two parts, the first dealing with the geological features of the Witwatersrand System bearing on the conditions of deposition of the auriferous conglomerates, and the second with the origin and distribution of the gold.

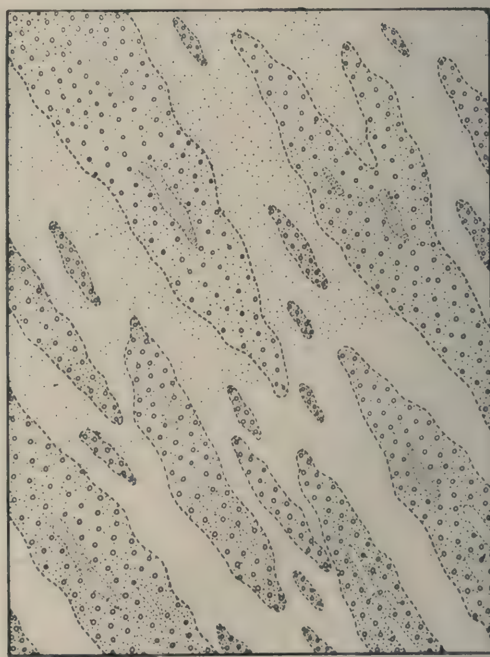
He commences by describing the general stratigraphy of the Witwatersrand System, and he shows that the quartzites, grits, conglomerates, and shales of which it is composed differ chiefly by reasons connected with the rate of flow of the currents from which they were deposited. The shales predominate in the lower portion, and he finds it convenient therefore to divide the System into Upper and Lower, at a point where this predominance ends, at the bottom of the quartzite containing the Main Reef group of auriferous conglomerates. In the Upper part of the System, only one argillaceous bed is found, known as the Kimberley Shales, and this is largely gritty and silicious. The auriferous conglomerate beds are found at various points throughout 20,000 ft. of thickness of the Witwatersrand System, in both the Upper and Lower Systems, but more in the Upper, where the conditions for deposition were more favourable. The Elsburg, Kimberley, and Bird reefs have been worked at places, but the lenses of ore are short. The persistence of the Main Reef group is the great feature of the Witwatersrand System. Dr. Mellor describes the physical characteristics of the Main Reef group, especially the Main Reef, Main Reef Leader, and South Reef, in sequence upward. He shows that the Leader is absent in the western part of the Rand, becomes more important in the central Rand, and in the far east Rand is the only representative of the Main Reef group. The Main Reef and South Reef are the most important in the west Rand, but they gradually disappear in the east Rand, and are entirely absent in the far east Rand. The Main Reef and the Leader are often so close together that they can be mined together. In the eastern part of the Rand, the separating rock



SECTION OF THE WITWATERSRAND SYSTEM AS REPRESENTED ON THE CENTRAL RAND.

between the Main Reef and Leader changes gradually from ordinary quartzite to a fine-grained silicious shale, the dark colour of which is responsible for its popular name 'the Black Bar.' This bar increases in thickness, and, concurrently, the Main Reef and the quartzites underlying the Main Reef group disappear, so that in the far east Rand the Leader rests directly on the Black Bar and the shales which constitute the uppermost members of the Lower Witwatersrand System. Thus in the far east Rand the auriferous conglomerate rests on a 'slate foot-wall.' In this connection it may be mentioned that the overlying Kimberley reefs resting in the Kimberley Shales bear some likeness to the Leader with its slate foot-wall, and confusion has occasionally arisen thereby in the interpretation of the bore-hole results. Dr. Mellor proceeds to describe the far east Rand and gives his reasons for concluding that the Nigel reef at Heidelberg is continuous through a great basin with the Van Ryn or Modderfontein reef. This subject was treated in full in the article published in our December issue. In the summary of the first portion of the present paper, it is shown that the rocks of the Witwatersrand System, whether shales, quartzites, or conglomerates, pass from fine-grain to coarse-grain, from the base upward. The Orange Grove quartzites, the lowest in the System, are finer grained than any above, and the shales, grits, and conglomerates, follow the same rule. Thus the sizes of the pebbles in the conglomerates are greatest in the Elsburg reefs and the average size diminishes in the reefs below. In seeking for a present-day analogue for the Main Reef group, Dr. Mellor has found the Nome deposit in Alaska of interest. Here is a low-lying auriferous coastal plain, extending for 30 miles in length and averaging 5 miles in width, and the physiographical and geological conditions resemble those that ruled during the deposition of the Main Reef group.

The discussion of the stratigraphy and of the nature of the beds and the auriferous conglomerates is given at some length by Dr. Mellor in his paper, for these considerations are of prime importance in determining the history of the contained gold. When only the central part of the Rand was known, with its steep dip, and with the petrological evidence obtained by examination of the banket both weathered and pyritic, the infiltration theory appeared to fit the facts the best, and the reefs could be taken to be lodes. The subsequent expansion of operations in the far east Rand, and the knowledge gained of the distribution of the gold in the conglomerate in that basin, caused Dr. Mellor to reconsider the question. Close examination of the Main Reef Leader, with its larger pebbles arranged at the bottom sometimes embedded in the shale foot-wall, and the gold richest near the contact, served to stimulate further inquiry. The result has been that Dr. Mellor has found the physiographical and geological evidence to outweigh the deductions obtained from the physical conditions of the ore, and that he was obliged to seek other explanations of these physical conditions. The mode of distribution of the gold in the conglomerate in the far east Rand is such as to suggest sedimentary deposition, for the auriferous conglomerate occurs in lenses which are in many cases isolated, the intermediate areas being usually devoid of conglomerate. Under these conditions it is difficult to see how the gold has been introduced by infiltration. Another feature difficult to explain by the infiltration theory is the occurrence of gold in the Bastard Reef, which is found in the Glencairn, May Consolidated, and neighbouring mines in the near east Rand. This reef consists of pebbles of Main Reef type sparsely scattered through a dark fine-grained matrix similar in constitution to the Black Bar. In places the Bastard Reef grades into the Main Reef, and at other places into the Black Bar. It is clear that the Bastard Reef originated by a mixture of Main Reef pebbles with finer material of the nature of the Black Bar, probably in many cases along the margins and the beds of channels cut through the pre-existing Main Reef gravels. Little gold is now found in the Black Bar, but the Bastard Reef containing Main Reef pebbles is in many places high enough in gold to be profitably worked. Typical Bastard Reef is an entirely unsuitable medium for the distribution of gold by infiltration, and the presence of gold in it is perfectly explained by the placer theory.



Diagrammatic Plan to illustrate the Mode of Distribution of Conglomerate in the Far East Rand.
Areas shaded with dots and ovals represent strongly developed conglomerate; areas shaded with dots only, less well developed conglomerate; unshaded, 'contact' only.

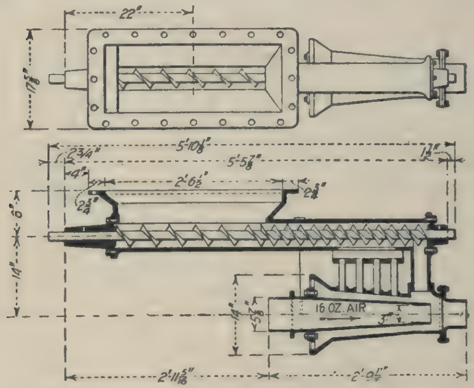
Opponents of the placer theory urge that no extensive and continuous placer deposit has been found analagous to the Main Reef group, but Dr. Mellor, after a study of the geological descriptions of the Nome coastal deposits by Alfred H. Brooks and others, finds a resemblance between these deposits and the Main Reef group. The opponents also consider that the gold content on the Rand is too high for placers, and that the gold is in too fine a state of division. By taking into consideration the whole of the conglomerates of the Witwatersrand System instead of merely the richer Main Reef Leader, it will be seen that the average gold content approaches more nearly that of an ordinary placer. And at many placers rich patches are found corresponding to the richer parts of the Main Reef Leader. With regard to the fineness of the Rand gold and the absence of nuggets, the deposits of Nome seldom contain nuggets weighing a pennyweight, and as such beds as the Main Reef Leader were probably laid down much farther from the actual shore line the gold would naturally be finer than at Nome.

As already mentioned, in the early days of the Rand, when steeply inclined reefs were mined, the deposition of gold from ascending solutions seemed the natural theory to adopt, but the isolation of auriferous banket in patches in the far east Rand introduced a difficulty in connection with this theory. Subsequent research has revealed no channels through which the solutions could have risen in the far east Rand. It is commonly supposed by many geologists not intimately acquainted with the Rand that the numerous diabase dikes afforded these channels, but Dr. Mellor, after persistent inquiry from the mine managers, has never been able to find an undisputed case where there is any connection between the dikes and the distribution of the gold. On the other hand there is evidence that the primary gold has been dissolved and reprecipitated at no great distance. Throughout the Rand quartz veins are found crossing the reefs. These veins are barren themselves, but where they cross an auriferous reef they have carried some of the gold with them, and this gold is crystalline in structure. These quartz veins suggest a cause for the alteration of the gold generally. With regard to the presence of pyrite and other minerals in the reefs, usually associated with lode deposits, the conglomerates and the adjoining quartzites contained large amounts of iron and much of the iron in the reef would therefore be an original constituent; but in addition there is evidence that some pyrite was introduced from other sources. Dr. Mellor adduces the case of the conglomerate at the Homestake mine in the Black Hills, Dakota, as described by W. B. Devereux, S. F. Emmons, and J. D. Irving. Here the gold of the conglomerate was derived from the detritus of the earlier Homestake lode. Some of the gold in the conglomerate retains its original worn and nuggety appearance, but some is of fine crystalline structure, indicating that it has been dissolved and reprecipitated. Moreover, the crystalline gold is associated with pyrite. This well defined case of crystalline gold in a placer conglomerate is of great importance as an aid to the interpretation of the origin of the Rand gold, and may be held to confirm Dr. Mellor's deductions from the evidence available on the Rand.

PULVERIZED COAL AS FUEL.

During the last ten years we have heard from time to time of applications of coal dust as fuel in metallurgical furnaces, cement kilns, steam boilers, etc. Theoretically the system of burning coal in the form of dust presents several advantages, the chief of which are the completeness of combustion with an absence of smoke, and the ease with which the furnaces may be started and stopped. Many practical difficulties in the application have had to be overcome, and methods and details devised and improved. The equal distribution of the heat and the prevention of points or zones of too intense heat have required study, and methods have had to be adopted whereby premature combustion or explosion of the coal dust is prevented. The subject is of such importance and the opportunities for economy in fuel are so great, that we take this opportunity of reviewing the developments of the system and outlining the present position. We base our information chiefly on two papers that have recently been published: 'Pulverized Coal, its Preparation and Use in Industrial Furnaces,' by S. H. Harrison, appearing in the February issue of the *The Engineering Magazine*, and 'Coal-Dust Firing in Reverberatory Furnaces,' by C. R. Kuzell, of Anaconda, presented at the Second Pan-American Scientific Congress held at Washington, and published in *The Engineering and Mining Journal* for February 12. It is by no means a novel idea to apply coal dust in boiler furnaces, though we are not aware that any boilers of this type have been extensively used. We described briefly in our issue of July 1910 the Bettington type that has been employed in South Africa and deserves development. The first successful use of coal dust was its application to the firing of cement kilns in 1895 by the Atlas Portland Cement Co. in America, though unsuccessful attempts had previously been made in the same direction by English firms of cement manufacturers. The American copper metallurgists noted the success of the cement practice, and in 1905 S. S. Sorensen equipped a reverberatory furnace at the Highland Boy smelter, Utah, with coal-dust firing apparatus. Two years afterward, C. F. Shelby applied the method at Cananea. These two installations, being pioneers, had many difficulties to overcome. In 1911 D. H. Browne erected a coal-fired reverberatory at Copper Cliff, Ontario, for the Canadian Copper Co. Many improvements were embodied in this design, and the plant worked successfully from the start. The most recent application is at Anaconda and at Great Falls, Montana. In our issue of September 1914, E. J. Carlyle described the plant at Anaconda, and *The Engineering and Mining Journal* for October 24 of the same year contained an account of the plant, written by E. P. Mathewson. Mr. Kuzell in his paper gives a useful bibliography of the chief articles and papers dealing with the subject. An important paper on the application of coal-dust firing in cement manufacture is that by R. C. Carpenter appearing in the *Journal* of the American Society of Mechanical Engineers for October 1914. The debt of metallurgists to their brother engineers in the cement industry is not confined to this one item, for it will be remembered that the tube-mill was borrowed from that source, while the merits of the cement ball-mill are now being slowly recognized in connection with coarse-crushing.

In applying coal-dust firing, the coal should be ground so fine that 95% goes through 100-mesh and 80% through 200-mesh. The Raymond roller mill is usually employed, but the Griffin mill is also in use. Before passing through the mills it is sent through driers, where the moisture is reduced to the required limit. At some plants the moisture remaining is 0·75%, but at Anaconda the figure is 2·5 to 3%. It is necessary to leave some moisture in the coal, otherwise the risk of premature combustion or explosion would be great. It is important also that air and moisture shall not come into contact with the coal more than is necessary, so screw conveyors are used wherever possible, and the bins are closed. When coal was used first for this purpose, the best quality of gas coal was sought, but nowadays a wider range is permissible. As compared with lump-coal heating of reverberatories, the range is also wider, and the old classification of long-flame and short-flame coals has no meaning, for the length of flame can be controlled by the damper, coal-feeders, and burners. Generally speaking, it may be said that any good bituminous coal and many poor qualities of coal may be used, unless the ash contains some obnoxious component. The ash of some coal becomes agglomerated into accretions in the flues and forms sticky masses, but the removal of these would be a matter of minor importance. Such ash, falling on the slag of the furnace, would be dissolved in the slag, and lime-rock might be added at the slag-skimming bay in order to complete the fusion. This difficulty is also met by finer grinding whereby the particles of inert matter are made so fine as to be carried readily by the draught entirely over the fire. Pyrite in the coal is not oxidized, but melts and drops into the charge. The conditions under which ash and pyrite are deleterious in cement kilns, steam boilers, and other applications are rather different. As much ash as possible should be carried through the furnaces, and either caught in settling chambers or discharged into the atmosphere. In cement kilns the ash is stated by Mr. Harrison to be beneficial to the clinker occasionally, and never to be detrimental to the quality of the cement produced. In metallurgical processes where sulphur is deleterious to the molten metal, the burners should be at a sufficient distance from the furnace to ensure a complete oxidation of the coal before the incandescent gases enter the furnace. Then the sulphur will be in the form of dioxide which does not attack the metal.



THE WARFORD BURNER FOR POWDERED COAL.

The present practice in constructing the burners is to use a low-pressure blast of 8 to 16 oz. per square inch. In earlier plant, compressed air at 60 lb. was employed, but this was found unnecessarily expensive. Several different makes of burners are used, but those employed by metallurgists are either of the Sturtevant or the Warford type. The former is used at Copper Cliff and elsewhere, and the latter at Anaconda. The coal dust is fed by a screw conveyor from a pocket in the bottom of the bin to an air-mixing chamber, from whence the coal-laden air-blast is conveyed into the furnace through a pipe. In the Warford burner, illustrated diagrammatically herewith, the screw is double-threaded in the conveying portion, with the object of more evenly distributing the coal. Some of the coal-dust drops through a slot in the screw casing and through four pipes into the mixing chamber below, and some is carried to the end and drops down the main discharge. The air current at 16 oz. per square inch is introduced through a central nozzle, and air from the atmosphere is drawn in through the ports at the back of the mixing chamber. Additional air is introduced into the furnace as required, but details of actual working are not given.

TUNGSTEN ORES IN GREAT BRITAIN

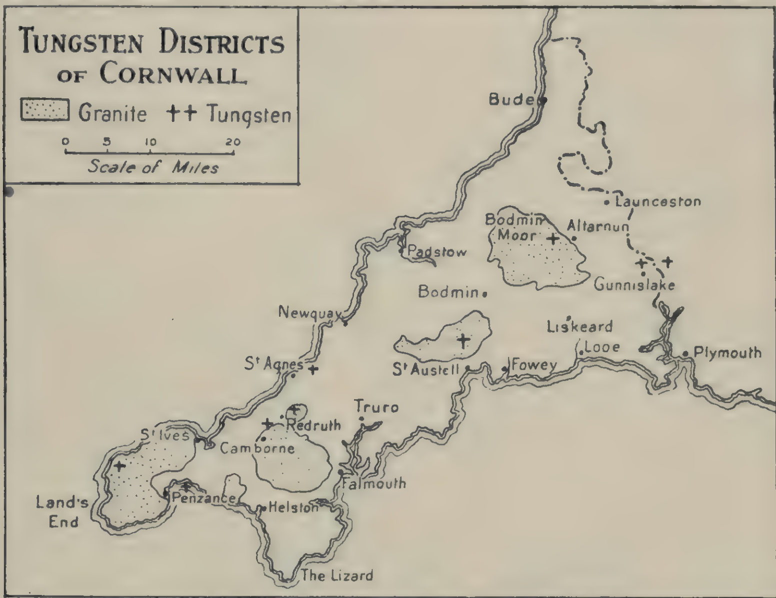
The Geological Survey is devoting attention to the mineral resources of the United Kingdom, with the object of helping manufacturers and engineers to secure supplies of substances hitherto imported, and a series of special reports is being published. The first of the series refers to tungsten and manganese ores, and it is written by H. Dewey, C. E. N. Bromehead, and others. The report gives general information relating to the ores, their occurrence in the British Isles, the method of treatment, and the output throughout the world; but the greater part is occupied with detailed descriptions of the known mines or deposits. On this occasion we shall deal only with the records of tungsten occurrences in this country. Before doing so, however, it is suitable to say that the United Kingdom has been a very small producer of either wolfram ($Fe\,Mn\,WO_4$) or scheelite ($Ca\,WO_4$), the yearly production having averaged only 200 tons of 60% concentrate out of a world's production of 6000 to 7000 tons. The leading producing countries are Burma, Portugal, Queensland, the United States, Bolivia, Peru, and Argentine, with New South Wales, Victoria, Tasmania, New Zealand, Japan, and Spain as other contributors. Until the outbreak of war most of the concentrate was sent to Germany. Since then it has been necessary to establish works in this country to produce the tungsten required for the manufacture of high-speed tool steel.

In Great Britain, tungsten ore is obtained chiefly in Cornwall, and also in Devonshire and Cumberland. Most of it is wolfram, but a small amount of scheelite is also produced, chiefly in Cumberland. In Cornwall the most important district is between Camborne and Redruth, where the East Pool, South Crofty, and Tincroft mines are regular producers. To the east of Redruth are the North Gorland and Park-an-Chy mines which have produced and may still produce much wolfram. A second district is in the granite area of St. Austell, a third round Gunnislake and Hingston Downs, and a fourth in the north and eastern part of Bodmin Moor round Altarnun. Deposits are known in many outlying districts, as Land's End, Wendron, etc., details of which are given later. The Devonshire deposits are over the Tamar river from Gunnislake. The Cumberland deposits are to the north of Skiddaw, near Caldbeck. In Cornwall and Devonshire the wolfram is found in veins in the granite and metamorphosed slate or 'killas,' sometimes associated with cassiterite, arsenopyrite, chalcopyrite, and fluorspar. In Cumberland wolfram and scheelite occur in veins in mica-schist, and are associated with galena, blende, pyrite, molybdenite, and bismuth, but not with cassiterite.

Proceeding to note the individual mines in Cornwall, the authors group them in the four divisions according to the districts mentioned above. As already stated, East Pool, South Crofty, and Tincroft are producers, and North Gorland and Park-an-Chy may be again. Near the last named is Wheal Peevor which was recently re-opened, and Poldice which is not at present worked. Near Land's End the Balleswidden is known to contain wolfram veins, but it has not been worked since 1875 and is now full of water. Scheelite used to be produced at the Levant mine, but none has been found for many years. At the Nancegollan, near Wendron, little devolopment has been done, and work is suspended, but there were indications of fairly rich wolfram ore. At St. Michael's Mount wolfram veins are known to exist, but it is not likely that any mining will ever be done on the island rock that carries Lord St. Levan's castle on its crest.

In the St. Austell district wolfram and cassiterite are found in groups of parallel veins suggesting stockworks, passing through kaolinized granite. The Bunny and Great Beam mines have been worked intermittently for wolfram, but as china clay is a more important mineral, little opportunity is offered to the metal miner. In the Redmoor district, two miles northwest of Lostwithiel, the Maudlin mine has been worked for scheelite. The authors include in the St. Austell district two occurrences of wolfram near Perranporth, which are geographically and geologically more suitable for inclusion in the Redruth district. One is the Great St. George & Droskyn, and the other the Cligga Head. The former is to the south of Perranporth, and the latter is on the face of Cligga Head, a granite headland, and is naturally difficult to work.

In the third district, around Gunnislake, the Hingston Downs and Clitters group of mines has been the most important producer. These mines were reopened in 1903 by Germans, who until the war began cut a big figure in London in connection with Cornish mining, at Clitters, and later at St. Agnes, St. Ives, and Truro, though the results have been invariably calamitous to the investor. Probably the Hingston and Clitters would be worth working by competent miners. Of other mines in the district the most important is the East Hawkmoor, which yielded well at one time, and during the last ten or twenty years the dumps have been picked for wolfram. The Kit Hill Consols is another old mine whose dumps have been worked for wolfram recently. The Drakewalls, Holmbush, Dimson, and East Kit Hill are old mines now abandoned that might well be re-examined.



The Bodmin Moor district is probably at the present time the most interesting to the prospector, as offering the greatest opportunities for finding profitable deposits. It is situated on the north and eastern sides of the granite boss, the highest point of which is Brown Willy, the chief hill in Cornwall. The Treburland mine was worked in past days, and has been much before the public during the last two or three years. The Buttern Hill, Cannaframe, and Halvana are properties recently developed actively. At Nine Stones Marsh the alluvial deposit resting on granite is being worked hydraulically. To the south of Bodmin Moor the Gazeland mine, on the St. Neot river, is being worked for wolfram.

Over the border in Devonshire, the Bedford United is being worked for wolfram. Farther east the Wheal Jewel, Friendship, and South Devon mines yield scheelite. The Bedford United is worked by the British Mining and Metal Co., of London.

METAL BUSINESS IN SOUTH AMERICA.

The metal and ore business of South America was at one time almost entirely in English hands. The mines were generally operated by local owners, and as a rule a comparatively small amount of English capital was provided, but the metal and the ores mostly came to England for realization or for smelting. Of recent years German and American buyers of metal and ores have had local representatives in South America, and American engineers and financiers have embarked on many mining enterprises introducing modern methods and large sums of working capital. This change in conditions formed the subject of a paper presented, at the Pan-American Scientific Congress held at Washington, by Ludwig Vogelstein, the well known German-American metal merchant of New York. This paper contained much matter of timely interest, so we quote from it at some length.

The mineral riches of South America was the objective of Spanish and English expeditions in the early part of the sixteenth century, and gold and silver were obtained in large amounts by conquest and otherwise. About the middle of the nineteenth century, after Chile had gained her independence, a great impetus was given to the production of copper by the establishment of smelters at Coquimbo by Charles Lambert, of Swansea. Until that time the output had come from high-grade oxide and carbonate ores. Lambert's reverberatory furnace erected in 1862, and his blast-furnace erected in 1857, made the treatment of sulphide ores possible. Chilean copper production soon assumed great importance, and became for a number of years, until about 1880, virtually the governing factor of the world's copper market. The facts that Welsh smelters established the industry, that British shipping provided the communications, and that the British banking system gave a stable monetary standard combined to place the control of the industry in English hands. For a long time bankers did the purchasing in South America, and arranged for the sales in the London market. In 1865 the London Metal Exchange undertook this work, and a firm of brokers in Valparaiso handled nearly the whole of the export business. In the eighties, the United States began to take an important place in copper production and metallurgy. During that period the works of the Balbach Smelting and Refining Co., the Baltimore Copper Co., the Nichols Copper Co., and M. Guggenheim's Sons, all on the eastern seaboard, were founded and soon assumed international importance, but, owing to lack of sea transport and banking facilities and the conservatism of producers, it was next to impossible for a long time to attract South American ores and metals to the United States. At the beginning of the present century it became clear that a different method of purchasing should be adopted if business was to be attracted, and that negotiations should be taken out of the hands of bankers and brokers. Buyers better acquainted with mining and metallurgical problems were sent from the United States to South America with the object of getting into direct contact with the producers. At first the local people looked askance at these commercial envoys, but when it was seen that their technical assistance became available, and that money was being brought into the country to be applied to practical mining and metallurgy, the prejudice began gradually to disappear.

The American ore buyers had, and still have many difficulties to combat, arising especially from the cumbersome methods of accounting for metals and ores prevailing in Chile and the adjoining countries, and from the variation in the rate of exchange. The practice of South American bankers is to assume the risk of exchange and guarantee a fixed rate on a given date. Consequently ore is often paid for before production or delivery, and the mine owners are not averse to being financed in this way and to be rid of variations in exchange and price. The American ore buyer finds this system highly disadvantageous to himself on occasions. His usual contract calls for certain deliveries during stated periods, to be paid for on the basis of current prices. He generally finds that deliveries come along freely at periods of high prices. But when quotations are low, the deliveries diminish and frequently cease. All sorts of excuses are given for non-delivery, such as lack of supplies or funds, or breakage of plant, or the incidence of holidays. On these occasions the ore buyer has to be a first-class diplomatist. The mine-owners are invariably improvident, and divide their profits up to the hilt. Consequently they are frequently short of working capital and call on the ore buyer to provide it. Alternatively they will desert the ore buyer and sell at a lower price to a local merchant, in the hope of interesting the latter in some scheme for raising funds.

The American ore buyer generally makes the mistake of not humouring the mine owner in the matter of contracts. He comes with a set of terms, which are probably logical and fair to the seller, but they are based on cold business, and have no human element to attract the local man's sympathy. A slight modification of the terms would immediately, in most cases, overcome the seller's prejudices. The Peruvian may want to sell his copper on the basis of the price of best selected, the Chilean wants the standard three months' quotation, and the Colombian and Venezuelan are used to the quotation for electrolytic wire-bars. The South American has been accustomed to receive cash before export, and it is therefore necessary that the American should arrange to have the shipments sampled and assayed before despatch. It will cost more to do this in South America than in the United States, but the seller will not object. A frequent source of trouble between the buyer and seller arises from the question of the amount of moisture in the ore. The owner of a mine in the desert districts, where dust rises every time the ore is moved, is apt to dispute the assay results on dry ore, and resents the deduction for 1% moisture in 25% copper ore. This matter requires delicate handling by the buyer. We may parenthetically remark that this difficulty is not unknown in the oldest of mining districts, Cornwall, as has been mentioned in our pages on several occasions. Another trouble experienced by the American buyer arises from the fact that in cases of dispute between the assays of the buyer and seller, the matter is referred to a local umpire who, Mr. Vogelstein states, generally gives his verdict in favour of the seller. Mr. Vogelstein also advises American buyers to avoid disputes likely to lead to a lawsuit, an item of advice which is always acceptable.

Aluminium Dust.—During the last few years, aluminium dust has been used as a producer of heat in the thermit welding process and in the manufacture of explosives, and as a precipitant of precious metal from cyanide solutions. At the present time much of the war demand for aluminium is for the manufacture of the explosive, ammonal, which is a mixture of ammonium nitrate and aluminium. The method of producing the metal in powdered form is not usually described in text-books, and we therefore reproduce here some information on the subject, given in an article by G. H. Clevenger in the *Mining and Scientific Press* for January 22.

The following is an average analysis of aluminium dust: Al 91·2%, Al_2O_3 5·8%, SiO_2 1·3%, Si 0·4%, C 0·23%, H_2O 1·07%, N may also be present. Aluminium dust is frequently adulterated with powders of other metals, particularly zinc and tin and, at times, also with mica. The difficulty of manufacture accounts for the relatively high cost of the dust, which, in normal times, is almost double that of the metal in other forms.

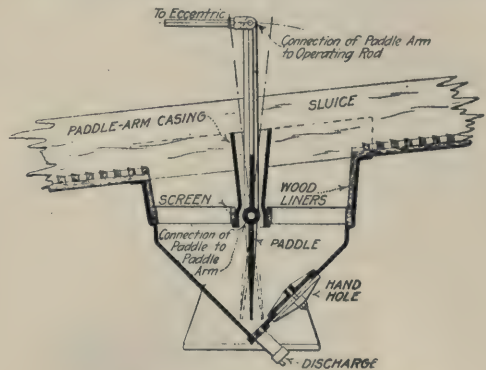
One method of manufacture involves the production of foil by a special system of rolling or combined rolling and hammering. The perfect foil is marketed in that form, while the imperfect foil, usually constituting 65 to 67% of the total is comminuted by stamp-ing, the finished product being separated by bolting and winnowing. The final operation is the polishing of the dust in a special device. Another method is to force gas or air into molten metal while it is setting, accompanied by vigorous mechanical stirring. The granules thus formed are powdered by stamps or in ball-mills. The finely-ground dust is separated and polished by methods similar to those previously described. In all the methods of making aluminium dust, it is necessary to add stearine, or some other wax, to prevent the welding together of the fine particles during crushing.

A source of much annoyance, if not actual danger, is the not infrequent explosions that take place during the various operations after the aluminium has become finely divided. It has been pointed out that this is probably due to the presence of an inflammable gas, as aluminium dust alone is not explosive. Carbon is always present in aluminium, presumably as the carbide, its source being the carbon electrodes used during the reduction of the metal. This, under the conditions obtaining in the grinding mills, probably produces methane. Thus 0·10% of aluminium carbide, which is not unusual, would be capable of producing 132·8 cubic inches of methane per pound of aluminium dust. In addition, there are the possibilities of the decomposition of water-vapour or the wax by the finely divided aluminium to form inflammable gases. These, mixed with air, are, of course, explosive.

Although a great deal of heat is generated during grinding, with ordinary precautions it seems improbable that the temperature would rise to the point of ignition of the gaseous mixture. Sparks might be formed through the impact of the steel grinding surfaces, but a more probable cause of ignition is the electrical discharges which are known to take place. This view is supported by the fact that aluminium dust at times ignites after it has left the mill, when allowed to stand in a solid pile. The dust becomes rapidly coated by a film of oxide which, although exceedingly thin, acts as an insulator. During grinding and polishing, a considerable amount of frictional electricity is generated. This is not readily conducted away on account of the insulating film of aluminium oxide. Potential differences up to 3000 volts are possible. Therefore, when the insulating film breaks down, electric sparks occur which ignite the gaseous mixture. As it is impossible to avoid explosions entirely, the units for producing aluminium dust are made comparatively small and are provided with loosely fitted iron covers so that, in event of an explosion, little damage will result. In one case an explosion occurred in a new plant 1½ minutes after beginning operations.

Tungsten Lamps.—The *Journal* of the Institution of Electrical Engineers for December 1 contains a description by E. A. Gimingham and S. R. Mullard of a new type of electric lamp which is likely to increase the demand for tungsten. This lamp is the result of research work done in the laboratory of the Edison & Swan United Company, near London. The object of the research was to produce a substitute for the arc lamp, enclosed in a bulb filled with an inert gas and having tungsten electrodes. The difficulty was to find an effective means for striking the arc. For this purpose a principle described by Sir J. J. Thomson, J. A. Fleming, and others was utilized, this principle being that the filament in an incandescent lamp gives off a strong negative discharge, and that if an additional electrode is placed near the filament and connected with a positive potential a current passes between the filament and this electrode. In the lamp ultimately evolved at the Edison & Swan laboratory, a positive electrode in the shape of a ball of tungsten $\frac{1}{16}$ in. in diameter is placed near an ionizing filament, through which part of the current is sent at first. When this filament incandesces, the gas between it and the ball of tungsten is ionized and made a conductor, so that a current can cross. The arc is thus struck and the ionizer circuit is automatically cut out. Virtually the whole of the light emanates from the small ball of tungsten. The applications of such a lamp are many. Its advantages over the arc lamp consist in its being enclosed and not naked, and in its requiring no attention.

Jigs on Gold Dredges.—In an editorial published in our issue of August last we made reference to a new type of jig invented by James W. Neill for application on gold dredges, the object being to save gold hitherto passing away into the tailing. In the *Mining and Scientific Press* for November 28, 1914, Mr. Neill gave an account of the use of jigs on dredges in California, and described the development of the idea. At first jigs of the Richards type, and afterward of the Woodbury type, were tried. The former failed to catch the fine gold, and the latter had the disadvantage



NEILL'S JIG FOR GOLD GRAVEL.

of being too cumbersome for the limited space available. Mr. Neill invented a new type with the object of increasing the screen area and of avoiding the nuisance of overhead pulleys and shafting. In the new jig the separate compartment containing the plunger is abolished, and the pulsations are instead obtained by the oscillations of a vertical paddle. It will be seen that the screen area is doubled by this device. In the *Engineering and Mining Journal* for January 29, L. H. Eddy gives further particulars of the application of the jig, on No. 7 dredge of the Natomas company. The concentrate obtained in the jigs is passed through Hardinge mills, and then to amalgamating plates. The equipment consists of two units of four jigs and one mill, one unit being on each side of the dredge. The discharge from the jigs is constant. The material coming from each Hardinge mill is passed over a shaking amalgamator and a plated table. Further information relative to the operation of and savings effected by the Neill jig would be welcome. Similar devices have recently been introduced in Australia.

Origin of Chalcocite.—Few problems in connection with ore deposits have been more discussed in recent years than those which centre round the occurrence and origin of chalcocite. The reason lies in the fact that this mineral is most important in the great ore deposits that are the basis of wholesale copper mining in America, and especially in those considered to have undergone secondary sulphide enrichment. At an early stage of investigation the mere widespread occurrence of chalcocite was considered evidence of such secondary enrichment. The finding of large bodies of the mineral at great depth at Butte, with evidence from other points as well, shook this belief, and led to more emphasis being placed upon 'primary' chalcocite. It became at once extremely important to be able to discriminate between the primary and secondary forms of the mineral. In 1913 L. C. Graton and Joseph Murdoch announced that a difference in cleavage was noticeable, and proposed to use this as a diagnostic criterion. The form of chalcocite showing a well developed cleavage in three directions at right angles to each other was considered to be primary. Another "shows, instead of cleavage, countless irregular cracks. . . . These closely spaced cracks commonly form the outlines of individual grains." This form was considered to have been formed by descending waters. The Geophysical Laboratory at Washington undertook investigations, and determined that chalcocite is dimorphous, being orthorhombic below 91° C., and isometric above. Artificial chalcocite, formed at high temperatures, showed the three well developed cleavages of an isometric mineral, while the low temperature orthorhombic mineral showed a basal etch cleavage of fine striations in one direction on each mineral particle. Mr. C. F. Tolman, Jr., undertook to study the ores containing supposed primary chalcocite in order to learn how far the differences in cleavage are truly diagnostic of origin. For this purpose he examined specimens of the chalcocite from the Bonanza mine of the Kennecott Mines Co. in Alaska, as that had been specifically and generally cited as an example of primary chalcocite. We mentioned last month our own reasons for questioning this opinion. Mr. Tolman now shows, in a paper published in the February *Bulletin* of the American Institute of Mining Engineers, that the well developed cleavage in the Bonanza ore is an inherited structure relating back to bornite and that, whatever may be true geologically, the chalcocite is secondary there in a mineralogical sense. He even found the two types of etching in a single grain of chalcocite, the bornite controlling in the centre of the mineral, while around it was a fine mosaic of striated orthorhombic crystals. Mr. Tolman also presents notes on the ores from the Apache mines near Tucson showing that the first formed copper minerals, chalcopyrite and bornite, were deposited at elevated temperatures, and that the complex breakdowns and replacements described in detail are the result of alternations which are taking place at or near the surface. Mr. Tolman also describes and figures a 'meta-colloidal' chalcocite; a mosaic of fine crystals preserving the structure of a gel in which the mineral is supposed to have been formed. This is held to have probably been formed at the top of orebodies, and is presumed to have been deposited by descending solutions. The final result of his observations is to show that the cleavage criterion cannot be used as proposed. No isometric etch figures were found in natural chalcocite that had not been inherited, and such figures were observed upon chalcocite probably formed by ascending, and also on that certainly formed by descending waters. The orthorhombic structure is found wherever that of the mineral replaced has not governed. All gradations were found between it and the meta-colloidal structure. Both of these differ from the more regular patterns. In many cases a second generation of chalcocite has the irregular pattern and a first generation the regular pattern.

The Cost of Zinc Extraction in America. — In *Metallurgical and Chemical Engineering* for February 1, C. A. Hansen gives most interesting estimates of construction and operating costs for electrolytic and distilling zinc plants. Mr. Hansen is connected with the General Electric Co., which at Bully Hill in California has conducted extensive researches on the treatment of complex zinc ores by electrolytic processes. The figures were prepared in connection with the proposed treatment of 200 tons per day of the concentrate made by the Butte & Superior company. Incidentally Mr. Hansen gives the following analyses of Bully Hill ore and the spelter being made from it by an electrolytic process:

	Ore %	Spelter %
Zn	29·0	99·98
Fe	15·0	0·0053
Cu	2·5	0·0050
Cd	0·3	0·0010
Pb	trace	trace
S	31·0	—
SiO_2	6·0	—
Al_2O_3	8·0	—
$BaSO_4$	3·0	—
CaO	1·5	—
MnO	0·6	—
MgO	2·8	—

The detailed estimates are reproduced below.

COSTS PER TON OF ZINC.

	Retort Process, Oklahoma	Electro-chemical Process, Butte, Montana
Plant capacity tons zinc per day	200	200
Cost per ton zinc:		
Salaries	$1·25	$0·93
Labour	11·30	6·00
Gas at 4c.	2·93	...
Coal at $2	1·67	...
Power at $26 hp. yr.	...	14·65
Clay	0·63	...
Repairs and sundries	1·04	4·14
	$18·82	$25·72
Fixed capital charges 16½% first cost	6·36	5·70
Total treatment cost	25·18	31·42
Freight on concentrate to Oklahoma	16·62	0·00
	$41·80	$31·42
Freight to St. Louis on zinc	2·60	9·00
Freight to New York on zinc	7·20	10·00
Treatment cost and freight per ton zinc:		
F.o.b. St. Louis	44·40	40·42
F.o.b. New York	49·00	41·42
Above figures neglect mining and milling costs to produce concentrates; also neglect relative recoveries of zinc values which would be:		
For retort process, say	87·0%	...
For electrochemical process	...	93·0%
Correcting for relative recoveries, the relative treatment and freight costs on above basis would be about:		
For St. Louis delivery	$44·40	$37·06
For New York delivery	$49·00	$38·06
Equivalent cost per lb. zinc at St. Louis	2·45c.	1·903c
Equivalent cost per lb. zinc at New York	2·22c.	1·853c.
Net value of silver, lead, copper in residues from Butte-Superior concentrate (26 oz. Ag.)	$7·20	$22·70

Mr. Hansen considers that they indicate that it would be more profitable to ship spelter than zinc ore from Montana, a conclusion seemingly substantiated by the recent action of the Anaconda company. The electrolytic plant, for 200 tons per day, including offices, laboratories, and sub-station, but not power plant, was estimated to cost $2,400,000 to $2,600,000. The equivalent retort plant was estimated at $2,800,000 to $3,200,000. Butte & Superior concentrate contains 55% zinc, and could 'carry' a power cost of $25 to $30 per horse power year. These rates exceed American Niagara charges by 40 to 65%, and are much higher than Norwegian rates.

Oil Shales in England.—At the meeting of the Institution of Petroleum Technologists held on February 15, W. Hardy Manfield read a paper entitled: 'Oil Shales, with Special Reference to those of the Dorsetshire Kimmeridge Series' The author describes the oil shales of the Oolite beds, and gives a history of the attempts to work them. There is no doubt as to the extent of these deposits or the oils that can be produced from them by distillation, but the large sulphur content is against their use at present, for no method of refining has been devised. The beds are to be seen on the cliffs between St. Alban's Head and Portland, and from there the outcrop passes inland in a curve, first northwesterly and gradually veering to the northeast. They have been traced by bore-holes through the southern and midland counties to Norfolk, Lincoln, and Yorkshire. The Heathfield natural gas, that caused some stir in Sussex a few years ago, came from these beds. It is believed that Kimmeridge, in Dorset, the village which gives its name to the series, was the centre of pottery manufacture in prehistoric days, and that the shale was used as fuel in connection therewith. In the sixteenth century the shale was employed as fuel for evaporating sea-water and the production of salt. Distilling furnaces were erected at Weymouth in 1848, and naphtha, burning oil, lubricating oil, etc., were extracted. The shale is high in ammonia, and the residue used to be employed as a fertilizer. In these days, when purchases from abroad will have to be more and more restricted, it is well to consider this possible home supply of spirits and oils, and research should be applied to the solving of the refining difficulty.

Antimony Mines in China.—At the February meeting of the Institution of Mining and Metallurgy, a paper was presented by A. S. Wheler on 'Antimony Production in Hunan Province, China.' For many years China, and in particular Hunan Province, has been the world's leading producer of antimony. The metallurgical and business centre is at Changsha, where the Hua Chang smelting company has its headquarters. There are a great many mines scattered throughout the province. Mr. Wheler describes some of the most important. The largest deposit is at Hsi-Keng-Shan, 21 miles east of the town of Sin Hua on the Tzu river. The country is underlain by Carboniferous dolomitic limestone with occasional beds of shale, sandstone, and coal. The strata lie in gentle undulations with low angles of dip to east and west. No igneous rock has been observed so far. The deposit is in an upthrust fault in the limestone, having a north-north-east strike and a dip of 15° to the east-south-east. The fault can be traced for several miles, and at a distance of 2½ miles to the south another but smaller deposit is found. Faulting is well evidenced by the abrupt scarp that marks the line of lode, by the brecciation which has been partly or wholly cemented with silica, and by the numerous slickensided clay selvages in the workings. The dolomitic limestone is from 20 to 40 ft. thick, and it is much faulted and fissured. The stibnite is distributed throughout it in seams, pockets, and big bunches for a distance of 6000 ft. along the strike. The ore is also found in the overlying sandstone, but in smaller quantities. The quality is high, as only traces of arsenic, lead, and copper are recorded. Along the line of lode about seventy different companies or individuals are conducting operations. The boundaries between the properties are often ill-defined, but disputes are rare. The method of mining is merely to follow the ore downward, extracting it as it is found, and leaving irregular chambers entirely unsupported. No effort is made to secure ventilation, and the fumes of native gunpowder mixed with the products of combustion of vegetable oil lamps render the atmosphere oppressive. The ore is roughly sorted underground and carried in baskets to the surface, where it is cobbed and hand-picked. The fine ore and mine sweepings are hand-jigged in circular baskets immersed in water. These concentrates are smelted locally to produce 'antimony crude,' which is really a sulphide matte. The production of metal is largely in the hands of the Hua Chang company. The output of the Sin Hua district is about 1000 tons of 'crude' per month and a few hundred tons of high-grade ore sent to Changsha for treatment or export.

The group of mines next in importance is the Pan-hsi. Here the country is mountainous and the rocks consist of shales with occasional layers of quartzites. These have been tilted and bent by a granitic intrusion. The stibnite occurs in narrow veins and usually as a narrow seam along the foot-wall and accompanied by a clay selvedge. The payable ore is in a series of short shoots, which have been followed down to depths varying from 150 to 550 ft. Another group of mines, at Wu-hsi, contains quartz veins through shale and slate containing gold and stibnite. These veins were originally worked for gold and the stibnite thrown aside, but they have been more recently worked for antimony and are promising properties. Mr. Wheler also briefly describes the An-hua, Chiang-hsi-lung, and Lung-shan mines. He gives information relating to metallurgical methods, statistics of production, and Chinese weights and measures.

Efficiencies of Blasting Explosives.—The January *Journal* of the South African Institution of Engineers contains a paper by W. S. Simpson describing experiments at the Vogelstruis mine on the Rand undertaken with the object of ascertaining by experience the relative efficiences of blasting gelatine and gelignite used with various primer cartridges. During the last few years there has been much discussion on the Rand with regard to the efficiencies of explosives, one of the chief points at issue being the advantages to be gained by the use of a ligdyn primer. Dr. Comey of Du Pont's in America, and W. R. Quinan at the De Beers explosives factory in South Africa, had shown that as ligdyn when used as a primer increases the speed of detonation of other explosives, its use in this way would give greater power to the total charge and would also have the advantage of securing the detonation of every cartridge in the charge. Ligdyn, we should parenthetically remark, is a dynamite using wood meal instead of kieselguhr and having a percentage composition of 40% nitro-glycerine, 45% sodium nitrate, 13% wood meal, and 2% wheat flour. Characteristic South African blasting gelatine has an analysis: 92·75% nitro-glycerine and 7·25 nitro-cellulose; 'reef' gelatine 67·1% nitro-glycerine, 25% ammonium nitrate, and 4% wood meal; and gelignite 56·4% nitro-glycerine, 2·5% nitro-cellulose, 30·7% sodium nitrate, 10·3% wood meal, and 0·1% sodium carbonate.

At the suggestion of the manager of Vogelstruis, T. H. Bayldon, the author of the paper made a great many records of ore won in the stopes and of the amount of explosive consumed, and he tabulates his results at considerable length. We need not recapitulate these or describe the methods of obtaining the records, and we confine ourselves to the author's conclusions. He found (1) that blasting gelatine was 25% more efficient than gelignite as an ore breaker and was therefore preferable in spite of its higher price; (2) the relative blasting efficiencies of blasting gelatine, reef gelatine, and gelignite were found to agree closely with their ballistic strengths determined in the laboratory; (3) ligdyn as a primer reduces the efficiency of blasting gelatine and reef gelatine to a large extent, and probably reduces the efficiency of gelignite also; (4) blasting gelatine gives a greater efficiency with No. 8 (stronger) detonators than with No. 6. As regards (4) we have already in abstracts of papers relating to the prevention of misfires recorded that the weakness or strength of the detonator is a point of importance. The fact that the author found the ligdyn primer of no assistance may be interpreted to mean that the high velocity of detonation secured by its use is not as suitable for rending hard rock as a slower transmission of the detonating wave. This is a technical point that is being studied by people interested in the Rand, and further discussion of Mr. Simpson's paper may be expected.

Mineral Resources of German Colonies.—The quarterly *Bulletin* of the Imperial Institute for October to December 1915, published at the latter end of February, contains a fourth instalment of a series of articles on the economic resources of German colonies. This deals with the German possessions in the Western Pacific Ocean. We have, in our issues of April and August of last year, quoted previous articles of this series, dealing with German East Africa and German Southwest Africa respectively. The German possessions now reviewed consist of the northeastern part of New Guinea, known as Kaiser Wilhelm's Land; the adjoining islands of the Bismarck Archipelago, namely, Neu Pommern, Neu Mecklenburg, Neu Hannover, Manus, and other smaller islands; Bougainville and Buka, in the Solomon Islands; and the Caroline, Pelew, Marianne (excepting Guam), and Marshall Islands. Of the mineral resources of these possessions, the phosphate deposits of Nauru, in the Marshall Islands, and of Angaur, in the Pelew Islands, are the only ones of present economic importance. These phosphate deposits are the result of the reaction of surface guanos on the coral rock of which the islands are composed. The deposits are high in phosphoric acid, and have been worked for export to Australia, New Zealand, and Japan. As regards other minerals, Tertiary brown coal is found at Astrolabe Bay in Kaiser Wilhelm's Land, and there are also indications of gold, copper, graphite, and petroleum in that colony, but none of these have been followed or developed. It will be seen, therefore, that the importance of the German possessions in the Western Pacific was not due to mineral deposits.

Rainfall in Nigeria and Gold Coast.—At a meeting of the Royal Meteorological Society held on February 16, C. E. P. Brooks read a paper with the above title. These countries are of immense value in connection with tropical agriculture, and the paper was prepared from this point of view. Gold and tin mines are not mentioned; nevertheless the paper will be of some value to many of our readers.

Bucket-Dredging in Nigeria.—At the February meeting of the Institution of Mining and Metallurgy, H. E. Nicholls presented a paper describing the bucket-dredge at Jos, in Northern Nigeria, and the results obtained. This is the pioneer dredge of the country, and owing to difficulty in getting fuel for steam engines, semi-Diesel engines were adopted. The author describes the engines, the dredge, the nature of the deposit, and difficulties of treating the deposit, and he gives records of output and costs. The paper is well worth close study.

TECHNICAL JOURNALS FOR THE MONTH

British.

Bulletin of the Imperial Institute.—*No. 4, 1915:* Resources of German Colonies in the Pacific; Occurrence and Utilization of Zinc Ores.

Colliery Guardian.—*February 11:* Mixed-Pressure Turbine Plant at a German Colliery. *February 25 and March 2:* The Campine Coalfield, northern Belgium, P. Krusch (from *Glückauf*). *March 2:* Precise Setting-out in Underground Roadways, P. Wilson Brown.

Engineer.—*February 11:* Zinc, Lead, and Silver Industries in Belgium, H. Hubert. *February 18:* Electrical and Chemical Industries of Belgium, H. Hubert. *February 25:* Portland Cement from Slag, B. J. Day.

Engineering.—*February 11:* Dry Blast in Iron Metallurgy, with an account of plant of the Steel Company of Canada [continued in issue of February 18]. *February 18:* Transmission of Electric Energy by Cables under the Sea from Sweden to Denmark.

Institution of Petroleum Technologists.—*February 15:* Oil Shales, especially those of Dorsetshire, W. Hardy Manfield.

Iron and Coal Trades Review.—*February 25:* Electric Winding, D. Burns, paper read at joint meeting in Glasgow of the Mining Institute of Scotland, National Association of Colliery Managers, and Association of Mining Electrical Engineers; 'A.T.M.' Winding-engine Signal Indicator; Erecting and Starting a large Capell Fan; Metal-cased Magnesite Bricks for Steel Furnaces.

Manchester Geological and Mining Society.—*February 7:* Connection between the Northwestern European Coalfields, X. Stainier.

North of England Institute of Mining and Mechanical Engineers.—*February 12:* The Hirsch Portable Electric Lamp; The Logic of Colliery Trams, J. Gibson, recommending standardization for mine cars as regards capacity and gauge.

Society of Chemical Industry, Newcastle section.—*February 16:* More Scientific Utilization of Coal as Fuel, H. E. Armstrong.

Colonial.

Canadian Mining Journal.—*February 1:* A Nickel Refinery for Canada, editorial discussion; Metallurgy of Canadian Cobalt Ores—II., R. W. Bridges, loss of silver in chloridizing speiss; Surf Inlet Gold Mine; Core Drilling at the Hollinger.

Mining and Engineering Review (Melbourne).—*January:* The Ardlethan Tinfield, J. R. Godfrey; Wages Award by Commonwealth Court.

Queensland Government Mining Journal.—*January:* The Warra Coal Mine near Brisbane, recently purchased by the Queensland Government; Tertiary Oil-Shales at Baffle Creek, L. C. Ball.

South African Mining Journal.—*January 22:* South African Geology in 1915; Asbestos near Carolina and Mica near Leydsdorp; Miners' Phthisis on the Rand, Dr. W. Watkins-Pitchford; Some Features of the Rand Gold Mining Industry, W. A. Caldecott.

FOREIGN.

American Institute of Mining Engineers.—*Bulletin* for *February:* Tests on Various Motor-Driven Equipments Used in Preparation of Anthracite Coal, H. M. Warren, A. S. Biesecker, and E. J. Powell; Interpretation of Assay Curves for Drill Holes, E. H. Perry and A. Locke; An Electro-Hydraulic Shovel, F. H. Armstrong; Conservation and Economic Theory, R. T. Ely; Conservation of Iron Ore, C. K. Leith; A Chemical Explanation of the Effect of Oxygen in Strengthening Cast Iron, W. McA. Johnson; Iron Mines of the Sierra Menera District of Spain, Victor de Ysassi; Use of Low-grade Phosphates, J. A. Barr; Iron Ores of the Philippine Islands, W. E. Pratt; Development of the Law Relating to the Use of Gas Compressors in Natural Gas Production, S. S. Wyer; Necessary Use and Effect of Gas Compressors on Natural Gas Field Operations, S. S. Wyer; Segregation in Gold Bullion, J. H. Hance; Brown Coal Mining in Germany, G. J. Young; New Electric Hoist of the North Butte M. Co., F. Moeller; Application of Electric Power to Mining Work in the Witwatersrand Area, J. N. Bulkley; Metallography of Steel for United States Ordnance, H. E. Cook; Certain Types of Chalcocite and their Characteristic Etch Patterns, C. F. Tolman, Jr.; Grinding Brass Ashes in the Conical Ball Mill, A. F. Taggart and R. W. Young; Modern Development in the Combustion of Blast-furnace Gas, with Special Reference to the Bradshaw Gas Burner, K. Huessener; Pennsylvania Fire Clay, L. C. Morganroth; Vacuum-fused Iron, with Special Reference to Effect of Silicon, T. D. Yensen; Researches on Fire Damp, E. Hauser; Magmatic Differentiation in Effusive Rocks, S. Powers and A. C. Lane.

Engineering and Mining Journal.—*January 29:* Jigs on a California Dredge, L. H. Eddy; Stripping the Hillcrest Iron Mine with a Sand Pump; A Tailings Sampling Device; Another Tube-Mill Lining, Algernon Del Mar. *February 5:* Nevada Packard Mill, R. B. Todd; Colloids and Colloidal Slime, E. E. Free, the first of an important series of articles discussing principles; Comparative Efficiences of Various Types of Air Compressors; Plymouth Lining for Tube Mills; Chrome-Iron Ore as a Lining for Reverberatory Furnaces, Edgar Hall. *February 12:* Special Pan-American Number containing a report upon the Second Pan-American Scientific Congress held at Washington, December 27; Improved Mining and Metallurgy, an Aid to Conservation, L. D. Ricketts; Buying and Selling Nonferrous Metals of South America, L. Vogelstein; Metallurgy of Native-Silver Ores of Southwestern Chihuahua, W. M. Brodie; Coal-Dust Firing in Reverberatory Furnaces, C. R. Kuzell; Mine of the Chile Exploration Co., Chuquicamata, Chile, Pope Yeatman; Metallurgical Operations at the Braden Copper Co, R. E. Douglass and B. T. Colley; Metallurgical Operations at the Chile Exploration Co., C. A. Rose.

Engineering Magazine.—*February:* Industrial Lessons from the German War Machine, C. E. Knoeppel; Factory Hoists, R. L. Streeter; Water Power Laws and their Relation to Industry and Progress, F. Darlington; Pulverized Coal—Its Preparation and Use in Industrial Furnaces, S. H. Harrison; Future of the World's Metal Supplies, D. M. Liddell.

Iron Age.—*February 3:* Breaking Down the Language Barrier, J. D. Hackett, teaching the foreign labourer to speak English by a system of instruction cards; Determination of Grain Size in Metals, Zay Jeffries, A. H. Kline, E. B. Zimmer, a new rapid method. *February 10:* Fixation of Atmospheric Nitrogen, R. G. Skerrett; Paying Bonuses to Indirect Labour; Sulphur Elimination in Coping Processes, J. R. Campbell. *February 17:* High-grade Manganese Ores of Brazil, J. T. Singewald, Jr., and B. Miller; Effect of Nitrogen in Steel; New Place of Magnesium in Industry, W. H. Grosvenor, uses in alloys as a scavenger, with methods and costs of manufacture.

Journal of Franklin Institute.—*February:* Rôle of Chemistry in the War; Application of Paper Pulp Filter to Quantitative Estimation of Calcium and Magnesium.

Journal of Geology.—*January-February:* Physiography of Mexico, W. N. Thayer.

Metallurgical and Chemical Engineering.—*February 1:* Hydrometallurgy of Zinc and Lead, C. A. Hansen; Oils and Other Reagents in Flotation, R. J. Anderson; Coal and Coke Efficiency in Blast-Furnace Operation, B. F. Burman. *February 15:* Calcination of Zinc Carbonate, W. P. Simpson; Grading Industries, II., E. S. Wiard, screens and screening; Lutes and Cements, S. S. Sadtler; Analysis and Assay of Zinc Retort Residue; Operation of the Blast Furnace, J. E. Johnson, Jr., the sequence of the charges; Liquid Chlorine, S. Ornstein; High Temperature Insulation, P. A. Boeck.

Mining and Engineering World.—*January 22:* Use of Welding Outfits at Mines, Mills and Smelters; Pumping Installations in the Leadville District, A. E. Guy; The Clark Compressed Air Meter, L. I. Davis. *January 29:* Angles, Elbows and Lay-Out Construction by a New Method, W. J. Smith; Redwood Stove Pipe for Mining and Power Use, H. B. Worden; Goodman Storage Battery Locomotives, E. C. De Wolf. *February 5:* Annual Statistical Review Number, with figures of mineral production; Unit and Content Prices of Tungsten and Other Rare Metals, W. M. Foote.

Mining and Scientific Press.—*January 15:* Theoretical Considerations Governing the Persistence of Ore, T. A. Rickard; Mining Districts of Northern Ontario, Robert Livermore; Economics of the World's Supply of Copper, T. T. Read. *January 22:* Aluminium Dust, G. H. Clevenger; Philip Argall, and Metallurgical Progress, T. A. Rickard; Flotation in Cuba. *January 29:* Research Problems, Will H. Coghill; Mining in Ecuador, J. W. Mercer; A Rock-Drill Stamp Mill, C. F. Weeks; Treatment of Miners' Inquiries, T. C. Witherspoon. *February 5:* Minerals Separation Contracts and Metallurgists; Washoe Reduction Works, Anaconda—I., L. S. Austin; Stamps and Competitive Machinery, E. C. Culter; The Present Value of a Mine, F. Sommer Schmidt. *February 12:* Glossary of Flotation; Influence of Technical Journalism on Mining Education, T. A. Rickard; Molecular Forces in Flotation, D. H. Norris; Industrial Opportunities in Siberia, C. W. Purington.

Salt Lake Mining Review.—*January 15:* Annual Review Number, with details regarding Utah mining districts in particular. *January 30:* Wyoming Oil and Coal Developments in 1915, C. E. Jamieson; J. P. Karns Heading Machine, a mammoth drill for tunnel work.

School of Mines Quarterly.—*July:* Retirement of Prof. H. S. Munroe; Valuation of Anthracite Mines, R. V. Norris; Chemistry of Furnace Efficiency and Air Supply, C. E. Lucke and E. D. Thurston, Jr.

NEW BOOKS AND OTHER PUBLICATIONS

The Salt and Alkali Industry. By Geoffrey Martin, Stanley Smith, and F. Milsom. Cloth, octavo, 110 pages, with illustrations. London: Crosby Lockwood & Son. Price 7s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

We have on several previous occasions referred to the series of books relating to chemical technology, issued by Crosby Lockwood & Son under the editorship of Dr. Geoffrey Martin. The volume now reviewed deals with the salt industry and alkali manufacture. The chapter on salt is short. Then follow accounts of the manufacture of hydrochloric acid, sodium sulphate, sodium carbonate, and caustic soda, and notes on the treatment of alkali waste. This section of the book relates to the old Leblanc process. The next section deals with the manufacture of sodium carbonate by the ammonia soda process. This is the process developed by Solway and introduced into this country by the late Ludwig Mond, who was backed by Lancashire soap-makers. Working details of the process have never been published, but as the patents have long ago expired, it was open to other chemical manufacturers to emulate the success of Brunner, Mond & Co. This was done by Ivan Levinstein, of Manchester, who founded the Ammonia Soda Co. Ld., and erected works in the Cheshire salt basin not far from the works of Brunner, Mond & Co. The author of the chapter on the ammonia soda process, Mr. Stanley Smith, is chemist to the Ammonia Soda Company, so it may be taken that his account is substantially correct, though possibly he may not be giving away any vital information. The electrolytic processes for the manufacture of soda were described in the book on 'Chlorine Products' belonging to the same series. Other chapters in the book deal with the Stassfurt deposits, and with potassium salts. It remains for us to congratulate the authors and the publishers on the issue of a most valuable handbook.

Dana's System of Mineralogy: Third Appendix to the 6th Edition. By W. E. Ford. Cloth, octavo, 100 pages. New York: John Wiley & Sons; London: Chapman & Hall. Price 6s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Dana's 'System of Mineralogy' was first published as long ago as the year of Queen Victoria's accession to the throne, when the author, James Dwight Dana, was 24 years old. The second edition appeared in 1844, the third in 1850, the 4th in 1854, and the 5th in 1868. In 1892 the 6th edition was published, and, embodying many rearrangements and additions, the book then assumed the form known to modern students. The rearrangement was undertaken by E. S. Dana, the son of J. D., and also, like his father, a professor at Yale. This edition has not required any change of form since its publication, but from time to time appendixes have been issued, keeping track of new minerals and new localities. The third appendix now presented has been prepared by W. E. Ford, another Yale man, to whom was entrusted the revision of Dana's 'Manual' four years ago. It is only necessary to say that the third appendix is a worthy supplement to previous work. The most important new development during the period between the publication of the second and third appendixes has been the application of X-rays to the study of crystal structure by two Englishmen, W. H. and W. L. Bragg. These scientists have contributed most of their announcements to the Royal Society, and for this reason their results are not so widely known as they should be. The award of the Nobel prize to them last year left the public uninterested. The appreciation of their work in this new appendix duly places on record the views of the skilled mineralogist.

The Mining Manual and Mining Yearbook for 1916. By Walter R. Skinner. Cloth, octavo, 1030 pages. London: W. R. Skinner and *The Financial Times*. Price 15s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is the thirtieth annual issue of an invaluable book, giving details of all the mining companies registered in the United Kingdom, and of some of the foreign companies the shares of which are known on the London Stock Exchange. We suppose that there are still a few benighted people who do not know Skinner's Mining Manual, just as we find that some folks have never heard of the Bible, Bradshaw's Guide, or Mrs. Caudle's Curtain Lectures. But we take this opportunity of expressing our personal thanks to Mr. Skinner for his excellent and accurate work.

The Gold Placers of Northwest Spain. By T. C. Earl. Paper covers, quarto, 28 pages, illustrated. London: *The Mining Journal*. Price 5s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The author has spent much time during the last few years studying the alluvial deposits of northwest Spain, and in this pamphlet he gives some account of operations and of the various deposits. The attempts to work placers on the river Sil attracted much attention a year or two ago, and we gave some information on the subject in our issue of March 1913.

Journal of the Iron and Steel Institute. Vol. 92. Edited by the Secretary, George C. Lloyd. This volume contains the papers, with discussions, presented at the September meeting held in London. It includes also the usual excellent digest of information culled from publications in all parts of the world, including Germany.

United States Bureau of Mines. Among the publications recently distributed by this bureau are three of more than usual interest. The first, No. 75, covers 'Rules and Regulations for Metal Mines' and was prepared as a model code by a committee consisting of W. R. Ingalls, James Douglas, J. R. Finlay, J. Parke Channing, and John Hays Hammond. These gentlemen were originally asked by the American Mining Congress to take up the work and they devoted such time and care to the task as to make the report well worth a place in the library of each mine manager.

The second, No. 98, is the 'Report of the Selby Smelter Commission,' consisting of J. A. Holmes, E. C. Franklin, and Ralph A. Gould. It embodies a mass of accurate and impartially collected detail such as has never before been made available, touching one of the great difficulties that metallurgists and smelter managers must face.

The last to be mentioned, No. 94, is in two parts, and consists of the 'Mining Statutes of the United States Annotated.' It was prepared by J. W. Thompson, law examiner for the bureau, and should be in the library of every engineer and lawyer concerned with mining law, as well as those companies which hold property in the United States and are subject to the vagaries of the land laws of that country.

YEARLY REPORTS OF MINING COMPANIES

Dolcoath Mine.—During the last few years it has been known that the developments in depth at the premier tin mine of Cornwall have been disappointing, and that the reserves of lower-grade ore would have to provide the greater part of the future output. The shadow cast by this impoverishment has been increased recently by the scanty amount of labour available owing to the miners enlisting for the war. The report for the half-year ended December 31 last shows a loss on the working account, the first time that such a loss has been recorded since the present limited company was formed in 1895. No dividend has been paid since the latter half of 1913, when 2½% was paid on the £350,000 capital. During the second half of 1915, the ore mined was 40,394 tons and the tin concentrate recovered was 508 tons, as compared with 42,676 tons and 678 tons during the first half of 1915 and 48,058 tons and 710 tons during the second half of 1914. The yield of concentrate per ton of ore was 28 lb., the average price obtained for the tin concentrate sold £89. 17s. 6d., and the amount realized £45,669. The last figure is the lowest recorded for many years. The total income was £46,989, the working cost was £48,935, and the lord's dues £3044. The working loss for the year was £4990, and in addition £2497 was written off for depreciation of plant, so that the balance of £11,461 brought in at the beginning of the period was reduced to £3979. Very little development has been done in any part of the mine during the half-year. As we recorded recently, the ownership of the mineral royalties has passed by sale from Mr. Basset to Mr. Hamilton Edwards, and his associate, Mr. Bond. The directors, at the time of the transfer, expressed the hope that the new owners of the mineral rights would provide part of the funds required for further exploration. The manager then had in view a plan for continuation of development in depth and for sinking below the 550-fathom level, where the low-grade zone was encountered in the neighbourhood of the bottom of the circular vertical shaft. Mr. Thomas expressed his view that there was a good sporting chance of finding ore below this level in spite of Dr. Malcolm Maclaren's adverse opinion. At the meeting of shareholders a different plan for further development was expounded. Instead of sinking deeper, it has been decided to investigate the western parallel lode between the Wheal Harriet and Stray Park sections of the property. The Harriet shaft has already been sunk to the 490-fm. level and connection made with the vertical shaft, and this level is being continued toward the Stray Park shaft.

East Pool & Agar.—These tin mines near Camborne, Cornwall, have been worked since 1834, and until 1913 the company was organized on the cost-book system. The gradual fall in the grade of the ore during late years crippled the financial resources, and development fell behind. In the latter year, Bewick, Moreing & Co. undertook the management, and through their influence £35,000 additional capital was provided. Since then development has been vigorously conducted. An important success has been achieved by lateral exploration, for a new lode has been found that promises to supply a large amount of ore. The report for the year 1915 shows that 81,426 tons of ore was raised and sent to the 9 Holman stamps. The yield was 597 tons of tin concentrate, 127 tons of wolfram, 804 tons of arsenic, and 15 tons of copper concentrate, selling for £53,042, £20,000, £11,219, and £112 respectively. The total receipts were £84,373, or 20s. 9d. per ton milled. The working costs were: Mining £37,740, treatment £27,069, general expenses £10,094, and development £10,754, making a total of £85,659, or 21s. per ton milled. The duty of each Holman stamp per 24 hours was 26 tons. The chemical assay of the ore milled was 15·1 lb. of metallic tin per ton, and of the tailing 4·59 lb. per ton, indicating a recovery of 69·7%. As compared with the results for 1914, the amount of ore treated was 167 tons less, but the products sold for £14,364 more. The increased revenue was due to the rise in the prices obtained for wolfram and arsenic, and the greater amount of these products extracted. The yield of tin concentrate per ton was lower, and the revenue from this source was less than the year before. The development of the new lode is giving interesting results. It was first found on the 240-fathom level, and from this point drifts have followed the lode, and cross-cuts have been driven from a rise put up from this level. The assays in the rise and the drifts give in many places high results. The lode has also been proved by a cross-cut on the 212-fm. level. A cross-cut is being driven on the 190-fm. level to meet the lode.

Carn Brea and Tincroft Mines.—This company was formed under limited liability laws in 1900 to acquire tin mines in Cornwall between Camborne and Redruth, which had been worked on the cost-book system since 1832. Of recent years the grade of the ore has been low and profits have been few and far between. Five years ago, E. S. King was appointed manager, and he endeavoured to improve the position. He was, however, unable to effect any radical change. Since his time, it has been deemed the best policy to close Carn Brea and devote sole attention to Tincroft. Lord Clifden, the owner of the mineral rights, has co-operated with the company, and he has provided funds for development and plant on easy terms. The report for the half-year ended December 31 shows that 29,795 tons of ore was raised and that the yield of tin concentrate was 298 tons, which sold for £26,632. In addition, £4541 was received from the sale of arsenic and £3463 from the sale of wolfram. The receipts from the sale of arsenic and wolfram during the previous half-year were £2356 and £1964 respectively. The total receipts for the half-year were £35,861, the working cost £33,245, and the lord's royalties £1326, leaving a profit of £1290. This is the first profit recorded for three years. The average price received for the tin concentrate was £88. 13s. 5d., the yield of tin concentrate per ton 22·46 lb., the receipts per ton from tin 17s. 10d. and from all sources 24s., and the working cost per ton exclusive of royalties 22s. 3d. W. Thomas, the manager, reports the discovery of wolfram in the upper levels. The directors consider that the prospects at the mine are better than for some time past.

Wolhuter Gold Mine.—This company was formed in 1887 to acquire claims on the outcrop in the central Rand, to the east of the Meyer & Charlton. The property has given indifferent results, and exemplifies the fact, often forgotten nowadays, that the ore on the outcrop in the central part of the Rand is not uniformly rich. Dividends averaging 10% have been paid in 1894, 1897, 1898, and from 1909 to 1915. The report for the year ended October 31 shows that 477,867 tons of ore was raised. Of this 254,040 tons was taken from previously reported payable reserve, 65,320 tons from low-grade reserve, 71,819 tons from reclamation, 36,688 tons from development, and 50,000 tons from excess stoping width and other sources. Of this tonnage 15% was removed as waste at the sorting station, and 406,050 tons was sent to the stamps. The yield of gold by amalgamation was worth £357,085, and by cyanide £137,150, a total of £494,235, being 24s. 4d. per ton milled. The working cost was £341,224 or 16s. 10d. per ton, leaving a working profit of £153,011 or 7s. 6d. per ton. Other expenses and taxes absorbed £41,486, and £107,500 was distributed as dividend, being at the rate of 12½%. The development work during the year disclosed 478,310 tons averaging 6·3 dwt. The reserve on October 31 was estimated at 1,263,320 tons averaging 5·8 dwt. Shaft-sinking has been completed, and the development of the remaining ground is now in hand. Judging by estimates previously published, the mine should have a life of five or six years. The control is with the Neumann group, David Wilkinson is consulting engineer, and E. E. Hardach is manager.

Viloro Syndicate.—This company was formed in 1904 to acquire a gold-gravel property in the Oroville district, California. Walter McDermott is chairman, and T. H. Leggett is consulting engineer. The first dredge was at work for five years. Subsequently No. 2 dredge worked for six years, but it was destroyed by fire in October last. The insurance money, $50,000, was duly collected, so that the balance of cost, $20,000, had to be written off. As there only remains 28 acres to be dredged, it is proposed to sell the property and liquidate the company. The report for the year ended October 31 shows that the difficulty continued with regard to the heavy clay overburden and the 'hardpan' overlying the gravel. High-pressure water-jets were employed to remove the clay adhering to the buckets, and the hardpan had to be broken by explosives. The average depth of the clay and hardpan was 16 ft. During the year 715,918 cubic yards of gravel was treated for a yield of gold worth £17,399, and the working cost was £10,771. London expenses absorbed £810, and income tax £1245. Dividends were paid amounting to £4288, being 6⅓% on the capital. During the eleven years of operation, 8,084,541 cubic yards was treated for a yield of £212,000, and the amount distributed as dividend has been £82,425, being at the rate of 117¾% on the capital, £70,000.

Le Roi No. 2.—This company was formed in 1900 by Whitaker Wright to acquire the Josie, Annie, Poorman, and other gold-copper mines at Rossland, British Columbia. The value of the properties was greatly exaggerated at the time of flotation, and the capital with which the company was saddled was, as usual in boom times, far too high. After the inevitable collapse, Lord Ernest Hamilton and his friends took control and placed the management in the hands of Alexander Hill & Stewart. Since then profits have been made fairly regularly, and if the nominal capital had not been so large the dividends might have been considered satisfactory. The report for the year ended September 30 last shows that 15,681 tons of ore was produced suitable for shipping direct to the smelters, together with 7905 tons of concentrating ore. The shipping ore averaged 10 dwt. gold and 1½ oz. silver per ton, and 2⅝% copper. At the concentrating plant 9467 tons of ore was treated averaging 1·88 dwt. gold and 0·52% copper, and yielded 828 tons of concentrate averaging 11·9 dwt. gold and 1·5% copper. The accounts show an income from the sale of ore and concentrate of £40,215, and a net profit of £12,471. Out of this, £12,000 has been distributed as dividend, being at the rate of 2%. The group of mines has a great ramification of workings. The chief point of interest at present is the South Rodney vein, which is being developed from the 1750-ft. level of the adjoining Le Roi mine. It is believed that this vein will provide substantial profits to the company in future.

Mount Morgan Gold Mining.—This company works the famous gold-copper mine in Queensland, and we have on several occasions related the variations in metallurgical practice necessitated by the increasing amount of sulphide in the ore. The report for the half-year ended November 30 last shows that 200,034 tons of ore was raised from the Mount Morgan mine, 116.492 tons being suitable for direct smelting and 83,542 tons being sent to the concentrating plant. The ore sent to the concentrators averaged 2% copper and 5·3 dwt. gold. The tables recovered 19,318 tons averaging 2·85% copper and 9·38 dwt. gold, and the flotation plant 4705 tons averaging 20·7% copper and 30 dwt. gold. At the smelter 119.051 tons of Mount Morgan ore averaging 2·4% copper and 8·6 dwt. gold was treated, together with 18,431 tons of concentrate averaging 5·6% copper and 12 dwt. gold, and 25,197 tons of Many Peaks fluxing sulphide ore averaging 1·4% copper and 0·16 dwt. gold. The total yield of electrolytic copper was 4310 tons and of gold 62,778 oz. The reserve is estimated at 999,393 tons of high-grade ore, and 1,723,364 tons of medium-grade ore. No estimate is given of the low-grade ore which has provided a large proportion of that treated during the last few years. As already recorded in our columns, a re-survey of the ore reserves is being made. It is noteworthy that the ore mined during the last half-year was lower in grade and higher in silica than was called for by the estimates. The accounts for the half-year show an income of £641,116 and a profit of £168,642. The dividends absorbed £150,000, being at the rate of 15% for the half-year.

Broomassie Mines.—This company was formed in 1901 to acquire a gold-mining property about 20 miles northwest of Tarkwa, West Africa. It was reconstructed in 1904 and 1909, and on the latter occasion Bewick, Moreing & Co. became consulting engineers. Much of the responsibility has recently been borne by A. M. Mackilligin, of the firm of Lichtenberg & Mackilligin, who is on the board of directors. The only dividends were paid in 1912 and 1913. In our November issue we announced that the reserves were exhausted and that work at the mine and mill had been suspended. The report now issued covers the thirteen months ended October 31 last. During this period, 56,754 tons of ore was treated yielding 21,174 oz. gold, and 4796 tons of concentrate yielded 5975 oz., making a total output of 27,149 oz., selling for £108,106. As regards development, an internal shaft was sunk from the 1350-ft. level at a distance of 1400 ft. south of the main shaft to a depth of 407 ft. At a depth of 300 ft. a drift was extended 199 ft., and a winze was sunk. At 400 ft. another drift was extended 105 ft. In no case was profitable ore disclosed. To the north of the main shaft, exploration was continued on the 770-ft. and 1170-ft. levels, and the drifts were continued to 2025 ft. and 1574 ft. respectively. Here again the results were disappointing. In August the ore reserve on the West Reef was exhausted. The East Reef proved to be of too low a grade to be worked by itself, so that mining and milling were suspended at the end of October. The underground plant has been withdrawn, and care is being taken of the surface machinery. The coal and other stores have been sold. A contract has been made, on a royalty basis, for the treatment of accumulated residues and the cyanide plant has been leased for this purpose.

183

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

EDGAR RICKARD, *Managing Director.* H. FOSTER BAIN, *Editor.* EDWARD WALKER, *Assistant Editor*

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CONTENTS.

REVIEW OF MINING

Introductory.—The South African mining market has been brisk recently owing to the excellent reports from a number of the mines in the Far East Rand that have recently arrived at the productive stage. Following on the successful Daggafontein deal, several proposals have been made for recommencing or continuing development work at other properties in the same neighbourhood, notably Grootvlei, Rand Klip, and Vlakfontein. The Welgedacht and Cloverfield plans appear to be in abeyance at present. As regards the Grootvlei, the controllers, Lewis & Marks, have sought to interest American capital, and engineers from the United States are now making an examination. Another section of the Stock Exchange to exhibit liveliness has been that devoted to tin shares, following the substantial rise in the price of the metal. In particular Nigerian and Cornish mines have received attention and many advances have been registered. Conditions in Cornwall are brighter now than for many years, in spite of the war, for in addition to the important discovery at East Pool & Agar, similar promising events have happened at Tresavean and Basset. Copper and lead have risen considerably in price during the month. The difficulty of shipping lead from Spain and the suspension of smelting operations in Mexico make the supplies of this metal scarce. As regards copper, the rise has been in connection with 'standard' metal, one of the solemn fictions of the Metal Exchange, and the price has been rushed upward on very limited dealings, much to the disadvantage of buyers whose contracts have to be based on current quotations. The highest price reached by 'standard' was £120. Metal quotations are generally unreliable at present owing to conditions caused by the war, such as the restriction of export and the absence of free supplies. And in this connection it is advisable to say that any quotations given in our pages are not, at our recommendation, to be used as bases for contracts.

Transvaal.—The output of gold on the Rand during March was 768,714 oz., and in outside districts 27,975 oz., making a total of 796,689 oz., worth £3,384,121, as compared with 727,346 oz., 26,248 oz., 753,594 oz., and £3,201,063 for February. The number of natives employed on the gold mines at the end of March was 203,575, as compared with 209,426 at the end of February and 185,239 a year ago. The number of natives employed on the diamond mines was 917, as compared with 970 at the end of February and 13,656 before the war.

Evidence accumulates that the East Rand Proprietary Mines is in an anxious position. The yearly report just issued shows that the ore reserve is being depleted, without much present expectation of any improvement in this respect. The reserve at the end of December was estimated at 4,800,000 tons averaging 6·3 dwt. per ton, a decrease of 600,000 tons and 0·3 dwt. during the year. For a mine of so great a size, where over 2,000,000 tons of ore is raised every year, this reserve is alarming low. Of the various sections, Angelo and Comet are fully developed, so no additions to the reserve can be expected from them; at Cason two of the drifts are in profitable ore; at Hercules two out of eleven drifts give satisfactory results; at Angelo Deep all the five drifts are in poor ground; while at Driefontein the reef is much disturbed. Water difficulties have delayed shaft-sinking and consequently exploration at depth. Mr. W. T. Anderson, the superintending engineer, expresses the hope that better results will be obtained by development both along the strike and at depth.

The policy of the Randfontein Central is not easy to follow, owing to the paucity of information vouchsafed to the shareholders and the public. A month or two ago it was stated that 300 stamps out of 1000 were to be hung up. The reason for such a step was not made clear at the time. A subsequent announcement shows that there is no intention of reducing the amount of ore treated, but that the ore is to be sent to the more modern Central plant. The company is an amalgamation, and owns a number of mines which have their own treatment plants. The South, North, and Robinson plants containing 100 stamps each are to be dismantled, and the ore raised from these mines is to be sent to the Central mill. This mill contains 600 stamps, and with the aid of tube-mills, can treat the amount previously sent to 1000 stamps. The other 100-stamp mill, belonging to the Porges section, is presumably still in use. The economy obtained by improved metallurgical treatment is expected to give a favourable turn to the profit-earning capacity of the company.

The Lewis & Marks group have interested American mining firms in the Far East Rand, and hope to secure thereby the necessary working capital for developing the Grootvlei property. An American syndicate headed by Adolph Lewissohn & Sons has sent Messrs. W. W. Mein, Karl F. Hoffmann, and Fred Searls, Jr., to make an investigation on the spot, and to report on the prospects and probable costs of such a venture. Three bore-holes were sunk some years ago at the Grootvlei, intersecting the banket at 2500 ft., 3340 ft., and 4040 ft. respectively. The sinking of two shafts was commenced, and depths of 55 ft. and 378 ft. were attained, but water then stopped operations. Mr. Mein is well known on the Rand, as he was an engineer for Wernher, Beit & Co. for some years, latterly being consulting engineer for several mines including New Modder and Modder B. Mr. Searls is an economic geologist of distinction.

Proposals are on foot for the reopening of the Rand Klip, a property in the northern part of the Far East Rand, adjoining the Modderfontein B mine to the east, and under the control of the Anglo-French Exploration Company. Developments on the reef had not given satisfactory results, for the average assay-value was only 4·6 dwt. over 21·7 inches, but the 'uniform irregularity' of the banket in the Far East Rand warrants further trial of this property.

Developments at the Bantjes have been encouraging lately, and the outlook has substantially improved. The drift from the Main Reef West Company's mine has disclosed ore in the Leader assaying 45 dwt. over 18 inches, and calculated over stoping widths the total ore disclosed averages 7·2 dwt. The shares of the company have consequently revived.

Additional revenue being required for the Union of South Africa, a tax on the export of diamonds is to be imposed. The amount of the tax will range from ½ to 5%, and will be based on the ratio of profits to gross revenue. Little inconvenience will be felt by the imposition of this tax at the present time, when the diamond business is quiescent or just showing signs of revival. The income from this source for the fiscal year now commencing is estimated at £60,000, and in normal times it would be £300,000.

Mr. W. H. Dawe, the retiring president of the Transvaal Chamber of Mines, announced that the average increase in the cost of supplies caused by the war was only 15%. The extra charges thus incurred totalled £1,500,000, or about 1s. 2d. per ton milled.

Rhodesia.—The output of gold during the month of February was worth £313,769, as compared with £318,856 during January and £286,789 in February last year. The yield at Lonely Reef increased from £11,458, extracted from 4020 tons of ore, to £13,247 from 4730 tons. The mining returns for February reported also the production of 30,976 tons of coal, 270 tons of copper, 6722 tons of chrome ore, 311 tons of asbestos, 38 tons of antimony ore, and 47 carats of diamonds.

West Africa.—The output of gold during February was worth £137,739 as compared with £140,579 in January and £144,034 in February a year ago. None of the mines exhibited any notable variation in the yield.

Nigeria.—The rise in the price of tin has galvanized the market for Nigerian tin shares. The Rayfield has been particularly prominent, owing to receipt of a message from Mr. J. M. Iles announcing good results obtained by boring on the Delimi property. Eight bores covering a width of 240 ft. indicated the depth of the deposit at 35 ft., and the average content 7 lb. per yard.

Nigerian communications have been improved by the opening of the bridge over the

Niger, so that the rails are now continuous from Lagos to Kano.

Mr. H. E. Nicholls has a good account to give of the Werf-Conrad dredge of the Jos company, which by the way formed the subject of a paper read before the Institution two months ago. As the power is supplied by a semi-Diesel engine, the figures are of particular interest, seeing that many engineers are of opinion that this type of engine is not suitable for dredges. During the year ended July 31 last the dredge ran 83% of the time and produced 339 tons of tin concentrate from 208,436 cubic yards. The yield per yard was 3·88 lb. The working cost was 11½d. per yard, but allowance for depreciation, freight, realization charges, royalties, etc., brought the cost to 23d. A dividend of £7500, being at the rate of 10%, was paid for the year.

India.—A year ago it was intended to raise new capital for the Jibutil mine at Anantapur in order to increase the scale of underground operations, but financial restrictions have put this plan in abeyance. The ore reserve averages 5 to 7 dwt., which is not sufficient to provide a distributable profit. At the present time development is restricted by the inability of the mine to provide the necessary funds out of revenue. The ore at Anantapur has not the free-milling characteristics of that mined in the Kolar district of Mysore. Only 43% of the gold was extracted on the plates. Subsequently blankets have been used instead, and the concentrate is amalgamated in a pan. This method has raised the recovery to 53% or over. The tailing is ground in a tube-mill and cyanided. It is interesting to note that these improvements have been introduced by Mr. R. H. Kendall, who had experience of similar difficulties at Ouro Preto.

The development work on the main lode at the Mysore mine has been in comparatively poor ground during the last year, and Mr. R. H. P. Bullen, the superintendent, fears that the yield per ton milled during 1916 will show a further decline. At the southern end of the property, in McTaggart's section, an ore-shoot has been discovered on the 3226-ft. level. This appears to be a shoot not known in the upper levels. It has been already proved for 400 ft. along the 3226-ft. level, and it averages 3 ft. wide and 14·8 dwt. gold per ton. A winze from this level is down 90 ft., and the ore averages 4½ ft. wide and 1 oz. gold per ton. Particulars of the results at the mine during 1915 are given in another part of this issue.

Of the mines in the Kolar district, the Ooregum presents the best report, and this is all the more encouraging seeing that the workings have reached a greater depth than those of the Mysore, Champion Reef, and Nundydroog. In both Bullen's and Oakley's sections the developments at depth, on the 52nd and 54th levels respectively, have been excellent, and the reserves have been doubled during the past two years, now standing at 2½ years supply. A new circular vertical shaft has been started to tap the Oakley's section at a depth of over 4000 ft. Bullen's shaft, farther north, was sunk vertically to the 43rd level, and was continued on the incline from the 40th level.

A fire broke out at the 1290-ft. plat at Gilbert's shaft at the Mysore mine on March 23, and the timbers at once burnt to the surface. For a day or two the smoke interrupted work in the other sections. The fire exhausted itself on March 31, and it was then found that Gilbert's shaft was intact below the 2240-ft. level. The means taken to prevent the spread of the fire proved highly effective.

Australasia.—In our last issue we recorded the intention of the Australian Commonwealth Government to prevent 'aliens' from holding shares in public companies. The Government soon saw, as we mentioned, that such an enactment would unintentionally work hardship to friendly foreigners, and the word was quickly altered to 'enemy aliens.' The law as finally enacted is stringent, for it also includes naturalized persons of enemy origin. All enemy holders of shares have to transfer them to the Public Trustee, who will hold them for twelve months after the war. The Trustee may sell such shares and will hold the money received.

The Amalgamated Zinc (De Bavay's) company announces that the manager, Mr. H. W. Gepp, is investigating an electrolytic zinc process in America, and that tests are being made there on the company's zinc concentrate. Negotiations are in hand with the Tasmanian Government for the supply of hydro-electric power. During the half-year ended December 31, 48,195 tons of zinc concentrate was produced, and during the same time 65,934 tons was shipped to America. If the company makes its own electrolytic zinc, the concentrate will be shipped from Broken Hill to Tasmania.

Operations were resumed at Great Cobar early in the year, and the first furnace was put into blast on January 9. The second furnace was started on March 19, and by the end of that month the expected rate of output, 400 tons of blister copper per month, was reached. The plan on which this work was based was outlined in our issue of April a year ago. The raising of £102,000 on receiver's certificates took some time, and eventually £40,000 of this amount was subscribed by the New South Wales Government. Once the money was available, Mr. Pellew-Harvey lost no time in bringing his proposals to fruition, and in fact full-scale operations were reached some weeks before the specified date. As the Port Kembla refinery is not able to handle the Cobar blister copper until August next, the output is being shipped in the meantime to Swansea and Liverpool. The ore reserve is sufficient for three years. Lateral exploration has been commenced, and encouraging results have already been obtained. The New South Wales Government is anxious that the company shall consider the question of co-operative smelting for the Cobar district, and probably some such plan will be evolved.

The dividends paid by West Australian mining companies during 1915 were in the aggregate £772,687, out of a production worth £5,140,189. The total production of gold since the commencement of mining in that State amounts to £119,927,912, and the total dividends to £25,474,756.

Egypt.—Gold mining in Egypt since the revival of interest fifteen years ago has not on the whole yielded much profit to the shareholders. Of the two chief properties operated by John Taylor & Sons, the Barramia continues to exhibit the characteristics of Egyptian mines, narrow irregular veins with occasional rich pockets. For some years the preference shareholders have received dividends, but last year the full 10% was not forthcoming owing to increased costs, and only 7½% was distributed. The other mine, the Om Nabardi, is the brightest spot at present. The reserve of high-grade ore has been increased, and the ore of lower grade, not included in the reserve, is sufficiently plentiful to warrant the erection of additional plant. The scale of mining and treatment will thus be extended and the general cost sufficiently reduced to make the treatment of the lower-grade ore profitable.

Canada. — The proposed profits tax on mines has received strenuous opposition, and the article by Mr. F. H. Hamilton in our last issue has notably strengthened the attitude of the opponents. Several concessions have already been made, one being that the principle of the wasting asset is to be recognized, and liberal allowance for depreciation of the mines will be permitted before the profits are calculated. Another grievance that is to be redressed relates to the greatly inflated share capital of some of the companies. Some of the companies have nominal capital of millions of dollars, though each dollar represented only perhaps 5 cents subscription. If 7% were distributed on such capital there would be no excess profits to be taxed, and by comparison, the companies whose shares are represented more nearly by cash would be unfairly hit. It is therefore proposed that 7% shall only be payable on the actual cash subscribed on the issue of the shares.

United States.—The strike at the Arizona Copper Co.'s mines interfered with the erection of the flotation plant. This consists of 85 Callow cells, and it should be completed by June. The chief concentrating plant, known as No. 6, is being enlarged, and its capacity will be increased from 3000 to 4000 tons per day. The old concentrator at Clifton is being remodelled, and will treat ore from the King and Longfellow North Extension mines. The capacity will be 500 tons per day; the ore is to be crushed direct in Marcy ball-mills to 48-mesh (Tyler screen), passed over tables, and sent to flotation plant.

The Plymouth Consolidated, working in Amador County, California, is substantiating Mr. W. J. Loring's opinions expressed on the reopening of the mine by an English company three years ago. During 1915 the ore treated was 129,500 tons, the yield £133,549, and the net profit £39,213, out of which £36,000 has been distributed as dividend, being at the rate of 15%. On the 1200-ft. and 1400-ft. levels the developments have disclosed ore of more than average grade. On the 2300-ft. level the main ore-shoot is of greater length than on the 2150-ft. level. Exploration is in hand on the 1500-ft. level for testing the continuity of the south orebody in depth.

Mexico. — The Exploration Company, which has of recent years done such excellent work in Mexico, is naturally hard hit by the present unfortunate political conditions. Of the mines controlled by the company, the El Oro has been idle since February 1915, the Santa Rosa since April 1913, and the Buena Tierra since September 1915. The company also holds shares in the Greene - Cananea. The depreciation of the Mexican holdings has had a serious effect on the financial position of the company, and the net deficiency stands at £206,881. The directors desired to meet the altered position by a reconstruction of the company, but permission was refused by the British Treasury. At the meeting of shareholders, the chairman, Mr. R. T. Bayliss, gave one of his characteristically business-like reviews of the position in Mexico, and others besides shareholders will do well to read his remarks.

The political news from Mexico is severely censored by the United States Government, and details of the results of the American expedition over the border for the capture of Villa are lacking. The Carranza Government appears to be jealous of the American advance, and states that the Villa forces have been scattered. That being so, the American troops are asked to retire. Conditions are such that employees of American mining and smelting companies have been withdrawn once more from the northern states of Mexico.

Peru.—At the meeting of the New Chuquitambo Gold Mines, the chairman stated that certain American engineers showed an inclination to purchase the property. The mines are in the Cerro de Pasco district of Peru, and might be worked to greater advantage on a different system from that possible at present. When floated in London in 1907, the promise was high, as was also the purchase price. Since 1907, when the capital was reduced by 16 to 1, small profits have been made. The deposits are extensive, if patchy, and the average content is from 2½ to 5 dwt. gold per ton. But the rock is soft and easily mined. The deposits have been described as fossil placers, and are classified geologically as Recent.

Russia.—We refer elsewhere to the troubles that have come to the Lena Goldfields owing to the nature of the dual control, financially and technically. The company, though registered in England, has declared its dividend in roubles, owing to so many of the shares being held in Russia. The Orsk Goldfields has also adopted this method of declaring a dividend. It is quite likely that the Lena company will postpone the purchase of the dredge until prices of material and congestion and cost of transport become less prohibitive.

The Irtysh Corporation reports that the zinc-smelting plant at Ekibastus, built to treat the Ridder ore, will be started in a few weeks. The manufacture of retorts commenced on March 12, and the Merton roasting furnaces are ready for operation. The necessary skilled staff for the smelting plant has been collected, so that no difficulties are in the way of a successful campaign.

Spain.—The Rio Tinto is a big company, and its business is extensive and varied, but its report and the chairman's address at the shareholders' meetings are in the inverse ratio. The report for 1915 virtually tells us nothing except that £1,031,250 was distributed on the ordinary shares, being at the rate of 55%, and as the chairman's speech occupied only half a minute in delivery, the total amount of information available for shareholders was not appreciably increased. We often wonder why this secretive attitude is adopted by the board of directors.

China. — The revolt is spreading in the southern provinces against the restoration of the monarchy with president Yuan Shih Kai as emperor. The latest seceding state is Kwangtung, the capital of which is Canton. The other states previously announcing their independence were Yunnan, Kwei-Chow, Kwang-Si, and Fu-Kien.

EDITORIAL

H. FOSTER BAIN, editor of this Magazine, arrived at Cape Town on April 5. He intends to visit all the more important gold, diamond, and copper mines in the Union of South Africa, Rhodesia, Congo State, and the South-West Africa Protectorate. The result of his observations will be forthcoming in a series of articles and comments.

PROPOSALS are being made that the Canadian Mining Institute should apply for a Royal Charter. If ever a body of mining engineers did work deserving such official recognition it is surely this society, and the petitioners are not likely to experience any opposition, unless, maybe, from the proverbial conscienceless objector, the Institution of Civil Engineers.

WE apologized last month for having to use unbleached paper owing to the restrictions recently laid on the import of the raw material. A forced change is always unpleasant at the time, and is therefore supposed to be a change for the worse. Subsequently, on experience, we not only become reconciled to the altered condition, but often are even ready to admit that the change has brought many advantages. In the case of the unbleached paper, we have already discovered in this office that the printed page is more agreeable to the eye than when the shiny white surface was used, and that much better results are obtained in the printing of the illustrations. If any apology is to be made, it should really be given to the unbleached paper for our disparaging remarks about it.

THE IMPERIAL INSTITUTE is in future to be under the control of the Colonial Office instead of the Board of Trade, and the Executive Council is to consist of representatives of the Overseas Dominions and of gentlemen nominated by the Colonial Secretary. After these many years of comparative failure, due to the indifference of the Government and of the individual business man, we may hope that King Edward's ideal may yet be realized, and that the material resources of the Empire may become better appreciated.

IN the midst of the clamour for scientific prospecting, it is refreshing to receive a breeze from the hills. The following was addressed to us by an inquirer from Central America: "Having located a vein of gold, I desire you send me information re best book on mining; also an instrument some call goldometer, gold needle, or gold finder, to locate the deposit." Seeing that the writer has located a 'vein of gold,' we know of no book or instrument that will increase his good fortune.

THE Ullrich magnetic separator at the Royal School of Mines has received renewed notoriety, this time during an application at the Patent Court, where the gift of the machine by Krupps was quoted by the Controller as a shrewd business method of educating the budding engineer. The matter before the court was an application by the Rapid Magnetting Machine Company for a license to make use of the Ullrich patents, the manager stating that though their own machines were competent to do everything the German makers claimed, the public and the officials were so obsessed with the German bogey that the German machine was still demanded. In the inquiry it was mentioned that Edgar Allen & Co. are already making separators on the Ullrich design for the Government, and a settlement of the rival claims of these two firms to use the patents remains to be effected.

MEN at the front write to say that their interest in mining technology has temporarily disappeared, and that after the war is over the one satisfying thing will be to live in peace and quiet. In the face of the great realities it is very difficult for them to picture themselves ever being greatly concerned again over details of business strategy and campaigns of development and production. We can sympathize with this point of view, and agree that the world will be all the better, for a more general realization of relative values than has shown on the surface of things in recent years. But we do not believe that the world will take our friends at their word when they do return. The work of reconstruction will be as big a job as the one upon which they are now engaged, and it will be a slower one. The men who have made good in one place will be needed in another, just as is true in the ordinary routine of life. The recent letter from the Council of the Institution of Mining and Metallurgy, calling attention to the desirability of keeping places open for the engineers when they return, is valuable more as affording an opportunity for those at home to testify their full intent, than because it is needed in fact. Places are being kept at every mine and mill, and when the armies disband there will be none more welcome, and none sooner set at work, than the mining men.

ILLICIT ownership of gold does not carry heavy penalties in West Australia, and we have on several occasions referred to the many serious losses suffered by mines at Kalgoorlie. The Chamber of Mines in vain urges that the punishment should involve imprisonment without option of a fine, and the old law still stands to the effect that the maximum penalty shall be £50 or in default six months' imprisonment. Recently three gold-stealers were fined £5 each, with a few pounds costs, a penalty that did not appear to the managers to meet the case. The Chamber looks with envious eyes at the procedure in Rhodesia, where a stealer and a receiver have each received sentences of one year's imprisonment in addition to a fine of £200, in default of payment of which another year's imprisonment was to be served. The standards whereby the enormity of the crime is judged in these two countries indicates the bias of the political control. The Rhodesian sentence is too reminiscent of the imprisonment meted-out to the stealer of wild rabbits or to the casual abstracter of a turnip from the field; on the other hand the West Australian penalties seem to be too lenient and not to be adequate to suppress dishonest practices. The actual ownership of gold found in a rock is often debated by the casuist, who flourishes at the present time at Kalgoorlie. In Great Britain the law is that unless a thing is really your own it does not belong to you and you have no right to its possession, and the careless snapper-up of unconsidered trifles occasionally finds himself indicted for 'stealing by finding.' On this principle all arguments as to ownership should be based. As regards the severity of the punishment, this should be measured by the degree of necessity for repressing an irregular proceeding. In the particular cases of gold stealing we think that both the West Australian and Rhodesian regulations might well be reconstituted.

Dual Control.

The control of Russian investments from London is no easy task in normal times, and now that mail and cable communications are subject to endless delay and possible confiscation, complications arise that would be avoided in ordinary times. However, dual control invested in widely separated executives does not lend itself to amicable agreement or high efficiency in either technical or financial management. Complicated shareholdings are certain to create confusion. Where the shares of the English holding company and the Russian operating company are both listed and have a free market, it is difficult to assess the proportionate value of the shares of either, particularly if rivalry exists for control. The technical ability of Russian engineers must not be ignored. Russia has a continually increasing number of capable men trained to assume the management of their mining enterprises. It is quite natural that they should resent the continued influx of large salaried foreigners if they consider that their own country can supply the demand. Until recent years, little or no opportunity has been afforded these men to familiarize themselves with actual practice, but our own engineers have established mining plants covering almost every branch of the industry, and the younger Russian engineers have been quick to learn and absorb our methods. It may also be said that in the management of investments many Russians are quite capable of assuming the responsibility. The spirit and pride of this big nation must be taken into consideration, and if dual control is an absolute necessity, it must be so organized that the local directors are not subjected to any reflection as to their capacity for sharing the responsibility or their suggestions in regard to general policy ignored.

Zinc Smelting in England.

On several occasions during the last few months one or other Cabinet Minister has raised hope in the business community of this country that steps are to be taken to protect the British producer and trader after the war, and thus encourage the foundation of many industries in connection with which we have hitherto been at the mercy of the Germans. These hopes have generally proved illusory, and the actual terms and conditions offered by the Government have been in the form either of a grudging concession or an absolute cold douche. In the case of zinc, present and intending producers wanted some guarantee that money employed on the erection of plant should not be wasted, that the facilities for purchase of ore should be settled immediately, and that the output and price after the war should be suitably safeguarded. Yet here we are after twenty months of war without any knowledge whether contracts made by English companies for the sale of zinc concentrate to Germany are to be entirely cancelled or are to be resumed when the war is over. And as for a protection to the producer against dumping after the war, the Government refuses to consider a protective tariff or a bonus of even £5 per ton, because such a course is contrary to the principles of free trade. The only concession to English smelters consists of allowing part of the excess profits to be used in extending present plant. The companies will be allowed to deduct from their excess profits the difference between the cost of new construction during the war and before the war, and they are to receive a 'reward' from the Munitions Department for extending their works, the reward being that they are allowed to deduct from their excess profits, before taxation, 50% of the pre-war cost of construction. The profits are of course very large at present with the price of spelter so high, but the excess profits tax would return a big slice of the profit to the Government as buyer of the output. It is stated that the English companies have gracefully accepted this concession and will proceed to extend their works. The concession, however, does not interest the companies that are desirous of founding new smelting works in this country for the treatment of the vast resources of zinc concentrate at present lying fallow or worked largely for the benefit of American and Japanese smelters. Such companies are forced against their wish to adopt a policy contrary to the best interests of the country. A Government Commission was appointed months ago to investigate and report on the requirements of the zinc industry, but as is usual with committees, nothing has yet been done. We protest against the waste of public funds expended in this direction, when the results fail so lamentably to solve a serious problem.

The Institution's Annual Meeting.

At the annual meeting of the Institution held on the 23rd of last month, the bravery and self-sacrifice of our absent friends were uppermost in our thoughts, and the touching tribute of Mr. Walter McDermott found a keen response in our hearts. Seven hundred out of a total enrolment of 2400 are with the colours, a proportion that can hardly be equalled in any other profession, particularly as the membership of the Institution is cosmopolitan in character and in consequence many members are ineligible for service for reasons of nationality. Of the remainder some are engaged in the manufacture of munitions or helping the Government in an advisory capacity, and the rest are rendering excellent service in the production of metals, thus strengthening Britain's position on the battlefield and in the world of finance. Mr. McDermott, who made allusion to age limits, is himself directing the building of submarines and the manufacture of shells, and similarly a large number of the older members are giving very real assistance to the great cause. But the most striking figures of all relate to the young engineers of the future. Out of 151 students at the Royal School of Mines eligible for service, 137 joined the colours, and eight are engaged in ammunition work; in addition to the students, thirteen members of the teaching staff are at the front. All are strictly volunteers; none waited to be called. The casualties have been severe, for 24 have been killed, 3 are missing and 27 have been wounded. On the other side of the account is the more cheerful record of 24 of the students having been decorated or mentioned in despatches. We join with Mr. McDermott in his expression of admiration for the pluck, devotion to duty, and effectiveness of all our mining and metallurgical fighters.

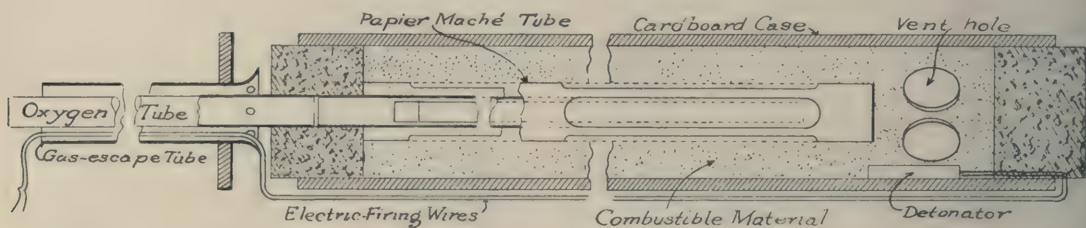
The annual report of the Council contained the gratifying announcement that £600 of the bank overdraft has been liquidated. This debt was incurred at the time of the purchase of the new home of the Institution. It stands much to the credit of the financial managers that such a strengthening of the position could be effected during a year of stress, and without any sacrifice in the efficiency of the Institution. It was announced that Messrs. Edgar Taylor, Edward Hooper, H. Livingstone Sulman, and F. W. Harbord had been nominated to the Government Committee on Research, and that the Royal Cornwall Polytechnic Society, by means of Government and other aid, had commenced the investigations into questions relating to improvements in the extraction of tin and tungsten from their ores. The vote of thanks to the retiring president, Sir Thomas Kirke Rose, met with a hearty response. He has made a most efficient presiding officer, always alert, terse, and kindly. Professor Carpenter rightly said that Sir Thomas had no proverbial blind side, in fact he did not think he had a blind back either. One vote of thanks did not appear on the agenda, and we will therefore propose it ourselves. This is to the writers of the excellent papers read during the year, and to the gentlemen who have taken part in the invariably interesting discussions. The high quality of the discussions is a feature of the recent meetings of the Institution, and the speakers generally show that they have taken special pains to do justice to the authors and to the papers.

The routine business having been completed, the new president, Sir Richard Redmayne, was inducted to office, and he proceeded to give his presidential address. Sir Richard is Chief Inspector of Mines, and previously was professor of mining in Birmingham University. His address constituted a plea for the more efficient development of the mineral resources of the United Kingdom and the British Empire, and the more economical use of the minerals and metals produced. It was an earnest appeal for the support of, and co-operation among, mineral owners for the more efficient exploitation of deposits. Many coal seams are lost for ever by the greedy extraction of the best parts or of better seams adjoining. Landlords block the erection of manufacturing plant, object to water being used for anything but trout streams, are callously indifferent to the requirements of mining operations. In our own special department, the lead, zinc, and tin miners are at the mercy of the owners of rights on the surface and below. Thus it is that extensive deposits now lie unworked, deposits of low grade it is true, but of no lower grade than many similar deposits in countries where operations are unfettered by vested interests. How are the sympathies of the owners of the rights to be enlisted for the good of the country? By peaceful persuasion or by the nationalization of mineral rights? The latter policy is rapidly approaching the stage of general acceptance by the community and by the individuals affected. Sir Richard also referred to the vast opportunity for economy in the consumption of fuel. Perhaps he was too narrow in his view that universal electrification is the panacea, for the one big unit has some disadvantages in comparison with the larger number of small units. Economy can be secured by the use of pulverized coal, by gasification of coal, the latter having the advantage of saving valuable by-products, and by surface combustion. The escape of black smoke and volumes of water vapour into the air indicates preventable waste, yet from our window in Salisbury House we can see factory chimneys and railway locomotives arrogantly breaking not only an economic law but the by-laws of the City of London. One of the most interesting points made by Sir Richard was his reference to the fact that within the confines of a comparatively small country like the United Kingdom there is to be found a greater variety of mineral deposits than in any other district of the world. The writer of this article has often drawn attention to this fact, which has usually surprised visitors from other countries accustomed to big mines and extensive ore deposits. Of coal, of course, our resources are enormous, and extensions of deposits are being continually proved. The various qualities range from anthracite and steam coal to free-burning bituminous coal and gas coal. Of iron ores we have hematite replaçements in Carboniferous limestone, carbonates in the Jurassic and Oolite, pisolitic ore in the Cambrian, and the so-called 'black-band' ironstone of the Coal Measures. Oil-shales are found in the Coal Measures in Scotland, and also in the Oolite from Dorset through the midland counties to Lincolnshire. British clays are famous everywhere, china clay, brick clay, and fire clay. Granite and other building stones are worked in abundance, as also are slates. Bauxite deposits are mined in the north of Ireland. Salt is plentiful in Cheshire, Staffordshire, Yorkshire, and North Ireland. The cement industry of Kent and Essex is of international repute. Of the other metallic ores, those of tin, tungsten, manganese, arsenic, copper, lead, zinc, magnesium, uranium, radium, gold, and silver are regularly worked; and of other products, strontium and barium minerals, gypsum, mica, and fluor-spar are the bases of important industries. Natural gas, nickel, and cobalt are also known, and have at times been obtained in commercial quantities. It will thus be seen that the economic geology of the United Kingdom is of greater interest than many people, at home and abroad, suppose or profess to believe. The opportunities for the scientific study of ore deposits in this country are favourable to the learner and to the older investigator. Parenthetically we may say that the lead-zinc deposits of Flint are nearly correlated to those of Joplin, which are discussed in this issue. Sir Richard's dictum relating to the wide extent of valuable mineral deposits in the British Isles may be supplemented by the reminder that the United Kingdom also presents the ideal stratigraphical example on which the science of geology throughout the world is founded. It is remarkable that within so limited an area the characteristic constituents of the earth's crust are so fully represented. No doubt this great variety of rocks and valuable minerals was the spur to scientific thought that evolved the theory of geology, as it certainly was the cause of the industrial prosperity of the country. We may suitably conclude by expressing our hearty support of Sir Richard's contention that the mineral resources of this country are not fully appreciated at the present time. Those who cannot supply physical force in overcoming the enemy should exert every energy toward encouraging the peaceful annihilation of the insidious rival, and a reasonable attitude of the owners of mineral rights and an intelligent supervision by the Government authorities should have an excellent influence in securing an adequate development of the country's resources.

Liquid Air as an Explosive.

Paragraphs have appeared in German technical papers and in the Press of neutral countries, and have subsequently been copied into English and Colonial papers, describing the application in Germany of liquid air as a substitute for ordinary mining explosives. Details are given relating to its application on the Rammelsberg mines, with particulars of the cost of manufacture and use. The cry is that this use of liquid air has partly obviated the necessity of relying on nitro-explosives, and to that extent has nullified the British blockade which prevents the delivery of Chile nitrate to Germany. We believe, however, that this is a typical German red herring devised to withdraw attention from the fact that nitric acid is now made chiefly from the air by methods described by us in our issue of June 1913, long before political bias could be suspected. However, whatever may be the motive of the Germans in publishing this information at the present moment, the technology of liquid air as a component of explosives is worthy of detailed consideration.

To avoid confusion in the minds of readers unacquainted with the subject, we may prefatorily state that, broadly speaking, modern explosives may be said to be made by treating various organic substances with nitric acid, the nitro body or nitrate thus formed being used with or without admixture of various oxygen-carrying salts such as ammonium nitrate, and sodium and potassium nitrates. Formerly nitric acid was entirely and still is largely produced from a natural nitrate, such as is obtained in Chile, by the action of sulphuric acid. Of recent years, however, the acid has been made on a considerable scale by the fixation of atmospheric nitrogen, either directly by electric discharge through air, or indirectly through the production first of ammonia, and the subsequent conversion of the latter by means of platinum sponge as a catalytic agent. The use of liquid-air compositions as substitutes for nitro-explosives was first proposed about twenty years ago, when Linde succeeded in producing liquid air on a commercial scale. At first it was supposed that liquid air by itself, placed at the bottom of a hole, if properly confined and heated to the temperature of the rock, would provide sufficient energy to rend or disrupt the rock. But the time required to transport the liquid air from the place of manufacture to the place where it was used, and to charge the hole, was too great; and, moreover, it was expected that it would disrupt the rock by accumulated pressure due to absorption of heat rather than by detonation. Linde subsequently presented the idea in a new light when he suggested that liquid oxygen should be used in preference to liquid air, owing to the greater capacity of the former to support combustion, and thus, when mixed with suitable organic substances, to promote conditions favourable to a rapid combustion or even detonation. When air is liquified, its two chief components can readily be separated, and both oxygen and nitrogen can thus be obtained for various industrial purposes. One of the uses of nitrogen produced in this way is to convert calcium carbide into cyanamide, a substance that subsequently can be made to yield ammonia. Linde then evolved the explosive known as 'oxyliquit.' He found that liquid oxygen, 90% pure, brought into contact with powdered charcoal or with petroleum absorbed in kieselguhr, produced a mixture capable of detonation; in fact, a very powerful explosive mixture was formed. But a great many difficulties were encountered in applying the discovery to practical blasting work, for the tendency of the liquid to assume the gaseous condition renders it almost impossible to load and fire the bore-holes before so much of the oxygen has escaped as to render the mixture practically non-explosive. Its industrial use therefore remained in abeyance for some years.



SECTION OF THE 'OXYLIQUIT' CARTRIDGE.

The method of applying this invention to rock-blasting is to make a cylindrical cartridge containing an annular cylindrical layer of powdered charcoal or mixture of petroleum and kieselguhr held in place by gauze. The cartridge case is made of cardboard, and it is fitted at each end with a cork. The liquid oxygen is introduced by a papier-maché tube which passes through one of the corks. The liquid is distributed through a loosely fitting cylinder having large gauze ports, and it passes through this gauze into the absorbent combustible material. Vent-holes are provided, so that gasified oxygen may escape to the surface. This gas passes up an outer tube as shown in the illustration. The detonator is arranged at the bottom of the cartridge and the electric-firing wires are brought to the surface through the outer tube. The supply of liquid oxygen is brought to the bore-hole in a vacuum flask. This flask has a special stopper that will screw to a flexible iron tube connected with the papier-maché tube of the cartridge. The stopper is fitted with copper rings which serve to conduct heat from the atmosphere to the inside of the flask, and thus to evaporate sufficient of the liquid to serve to drive the rest into the cartridge. By this arrangement the oxygen can be driven along a hole in any direction.

On reading this account, a number of practical considerations will immediately arise in the minds of mining engineers. For instance, as the explosion must be brought about as soon as possible after the oxygen is introduced, it is impracticable to fire many shots in the same round, and the method would be unsuitable underground or in any other situation where a substantial amount of time is occupied in transferring the men to a place of safety. The method could, however, in some circumstances conveniently be used for quarrying or in the excavation of railway cuttings or foundations for buildings or other structures. The engineer will want to know the cost of the oxygen mixture as compared with an ordinary explosive, and he naturally does not relish the idea of having to manufacture his own explosive on the spot and to make his own charges as required. The danger of allowing the liquid oxygen to be enclosed after it leaves the vacuum flask, and the necessity for dashing to a place of safety and igniting the charge as rapidly as possible, are two factors causing substantial inconvenience. The question arises as to the minimum diameter of the hole necessary to accommodate a cartridge of the new composition equivalent to the standard strength. A hole of at least 2 inches diameter will be required, a size not conducive to economy in drilling. Another point is that to secure the safe placing of the cartridge, it is necessary that the hole shall be even and straight. The objection can be urged that the strength of the charge can only be regulated by the size of the one cartridge used in each hole, instead of by increasing the number of cartridges. If such variation in the strength of the charge is desired, it is necessary in the case of the new composition to have a variety of cartridges of different lengths, or to drill wider holes and have cartridges of varying diameters. But in any case the bulk of the cartridge lengthwise, as well as in diameter, required to produce a given effect is so much greater than when ordinary explosives are used, that its relative efficiency and the relative cost of drilling are very much against its adoption. The question of fumes emanating from this type of explosive has to be considered. It is claimed that the fumes are quite innocuous and not perceptible, but engineers who have had the opportunity of making independent investigations are far from corroborating this claim. The necessity for the hole to be dry is obvious, for any water present would be immediately frozen by the liquid oxygen, which would then be unable to mix with the organic material and no explosion would occur. To counterbalance the disadvantages, the Germans assert that the cost of 'oxyliquit' is a quarter of that of blasting gelatine, but the conditions assumed in making this estimate must be known before the figure can be accepted as a guide. It is stated also that the strength of the explosion obtained lies between those of blasting gelatine and gelignite. One advantage that may be rightly urged in favour of this method is the absence of danger from misfires, for in case the detonator fails the charge soon becomes harmless owing to the evaporation of the oxygen. We have in the above description indicated the principle of the method, and have weighed some of the advantages and drawbacks. Our readers will probably agree with the view expressed in our opening words, and will judge the value of the process to be political rather than industrial.

A Cornish Mining Board.

In our last issue we referred briefly to the proposal made by Mr. C. A. Moreing at the meeting of shareholders in the East Pool & Agar Company that a Central Mining Board should be established for Cornwall. As the matter vitally affects the future of Cornwall's chief industry, it is desirable to examine the possibilities and advantages that would certainly result from the formation of such a board. Engineers and geologists are of opinion that there are still large areas in Cornwall where systematic development would disclose important mineral lodes. A recent and vivid proof of the correctness of this contention is provided by the discovery at East Pool of a rich parallel lode. But in order that steps shall be taken for the discovery of these deposits, and the deposits when found exploited to the best advantage, some concerted action is necessary first to secure profitable results at the mines now operated, and so make Cornish mining attractive to the capitalist. Our Cornish correspondent has long urged the establishment of a Chamber of Mines on the lines of the successful South African and West Australian Chambers, but for one reason and another, little or no desire has hitherto been shown by Cornish mine managers to co-operate with the object of solving problems common to them all. This attitude of aloofness can often be traced to the poverty of ideas of the old managers, for owing to the short-sighted policy of Cornish companies in paying salaries insufficient to attract enterprising men, those in charge of the work were of the old rule-of-thumb school. As these men were unequal to tackling the problems of increased cost and falling mineral content, they were loth to discuss matters with each other. Of late years a better qualified and more virile type of manager has come into Cornwall, and for this reason we consider that the time is again opportune to invite them to combine forces in the direction indicated.

There are many pressing problems awaiting the attention of such a Mining Board. Mr. Moreing, at the East Pool meeting, referred to two problems, drainage and ore treatment. As regards the question of drainage, practically all the mines working round Carn Brea hill are connected underground, and the closing of any one of them is a distinct menace to the others. Some plan should be evolved, and be in readiness beforehand, to safeguard the other mines whenever any individual company desires to cease pumping. A systematic study should also be made as to the sources of the mine water and the channels through which it flows, so that such part of it as comes from surface rainfall in the immediate neighbourhood may be diverted. By this means, the heavy pumping costs might be materially reduced. The expense of testing new methods of concentration and extraction should, as Mr. Moreing suggested, be spread over all the mines represented on the Board, and the results obtained and the data collected should be available to all. It could be arranged for each mine to test a different process or method, and in some cases for tests to be conducted concurrently at two or more mines. The question of power is another that should be considered, for the price of coal is a serious factor in the working cost, and co-operation in buying might conceivably result in a considerable saving being shown in this direction. The erection of a central electric power station for mines around Carn Brea hill might also be discussed. If the 'lords' become associated with the Board, conferences might well result in more equitable leases and the elimination of many of the existing anomalies, and thus remove obstacles restraining the flow of fresh capital into the county. The mapping and correlation of the vein and fault systems is an important matter, the necessity for which has long been recognized.

Mr. Moreing's view is that the title of an organization such as is proposed should be the 'Mining Board of Cornwall,' and that its office should be at Camborne or Redruth; that every mine and every mineral 'lord' prepared to subscribe should be entitled to representation on the Board; that the mines should be represented by their managers; that there should be a chairman or president, vice-chairmen or vice-presidents, an honorary treasurer, and a paid secretary, the latter for preference being a mining engineer. As the success of the Board would largely depend on the work of its secretary, it is important that some one familiar with the conditions ruling in Cornwall and commanding the confidence of the mining community should be appointed. The Board must be assured of a substantial annual income if it is to be worked on the lines indicated, but if the income at the outset is insufficient to provide a paid secretary, doubtless a capable enthusiast would, at any rate temporarily, undertake the duties in an honorary capacity. As we said at the outset, the need for co-operation is urgent, and we believe the time is ripe for the formation of such an organization. We shall exercise all our influence for its establishment and for its working success.

THE URALS AND THEIR MINERAL WEALTH

By T. H. PRESTON.

A brief review of a great mining region that has been noted for centuries and promises to increase in importance in the near future. Iron, coal, platinum, gold, and copper are the important minerals and metals.

THE Urals, which geographically form the dividing line between Russia and Siberia, lying respectively in Europe and Asia, occupy an area of about 120,000 square miles and stretch from the snow lands of the Arctic Ocean to the hot and dusty steppes of Orenburg. The geological formation of the Urals proves them to be ancient, and great valleys have been cut into the rocks, making accessible the mineral wealth. Mining began 500 years ago with the discovery of salt. Although salt was mined in the 14th century, it was in 1517 that Ivan the Terrible sent Stroganoff to the Urals to build the first salt works there. Later, during the reign of Mihail Feodorovich, the first Romanoff, in the 16th century, Zagraskim and an Englishman, John Water, were sent to Perm to prospect in the Urals. The first iron ore was found by a Tartar, whose name is unknown, on the river Nitza, near the place where the town of Irbit now stands. The first iron smelter was built here. The first real blast-furnace, part of the original of which is still in existence, was the Neviansk, built in the year 1699.

Copper was first found in 1635 on the lands of the Monastery, Solikamsk, north of Perm on the river Kama, and the first works was erected there in 1697. Gold was first found, strange to relate, in quartz veins, before the alluvial deposits were found. In 1744, Markoff found a vein near the lake of Shartash, five miles from the town of Ekaterinburg. The Russian Government brought in skilled labour, and mines in this district have been worked ever since. It is here that the famous Beresoffsky is situated. These mines now produce £120,000 in gold per year. In the eighteenth century the gold-bearing alluvium was discovered, and was worked for the Government by prisoners. Other alluvial work was started about the same time by Krilatoff on the river Chosovaya. After these, various other gold deposits in other parts of the Urals, such as Miass, Kyshtim, Verh Isetsk, etc., were opened.

Thus, over a period of 500 years, the mineral production of the Urals has progressed from salt to iron, iron to copper, copper to gold, and so on. It includes today platinum, asbestos, pyrite, chrome, manganese, graphite, coal, precious stones, and building materials. In addition there are minor amounts of zinc, nickel, mercury, and petroleum. From the point of view of modern mining, the Urals may be considered in their infancy. In copper mining the discovery of the copper-bearing sulphides on the Kyshtim property about five years ago began a new era. In the gold mines shafts of over 400 ft. deep are practically unknown, and most of the production has come from surface washing and quartz mining to a depth of 200 ft. or so. Diamond drilling has done more to prove the deeper bodies of sulphides than anything else, and since the discovery of the Kyshtim lodes, great attention has been paid to similar surface indications in other parts of the Urals.

IRON AND STEEL.—Were it not for the limited amount of fuel available locally, the Urals would undoubtedly occupy an even more prominent position as regards the output of pig iron, steel, etc. Blast-furnaces have been operating for the last 200 years, and large iron ore reserves are to be found on the whole of the line from Cherdin district in the north to the southern parts of Orenburg. All the formations from the very oldest contain iron ores varying from each other in form, size, and metal contents. The most frequent consist of limonite, being mainly bog iron, an average analysis being: Fe 52 to 55%, SiO_2 5%, S traces, P 0·3%. Thousands of such deposits are to be found, and they are largely responsible for the pig iron output of the Urals. If the bog iron deposits are famous for their number, those of magnetic iron are similarly notable for the size of the individual deposits. The largest are the Blagodat, Visoky, and Magnitny, all in the central Urals. A characteristic analysis of a magnetic iron would be: SiO_2 3·9%, FeO 19·59%, Fe_2O_3 63·94%.

There are 78 private and 14 government works engaged in metallurgy in the Urals, and the following table will serve to give some idea of the more important ones, with their productions during the year 1913.

	Pig iron in poods*	Manufactured iron, steel and rails in poods*	Copper in poods*
Government:			
Koushvinsky	1,673,262		
Zlataoustoff	2,375,828		
Botkinsky	—	2,437,929	
Private:			
Sissert from 5 works...	1,797,264	1,013,218	81,186
Verh-Isetsk from 6 works...	3,065,002	1,459,535	85,006
Tagil from 9 works...	1,758,877	5,715,759	86,765
Kyshtim from 3 works...	1,255,052	1,261,553	485,722
Bogoslovsky from 3 works...	2,119,014	7,198,719	250,594
Totals from 14 government and 78 private works during the year 1913, in poods	55,940,318	38,135,289	989,273
British equivalents of totals................	tons 902,262	tons 615,085	tons 15,596

* 1 pood = 36·1 lb.; 62 poods = 1 long ton.

The quality of the iron smelted in the Urals is highly prized for its softness, largely owing to the fact that it is smelted with charcoal and not coke. Of the 185,876,152 poods of iron produced in the Russian Empire in the year 1910, 46,962,247 poods were smelted in the Urals with charcoal. The cost of production in the Urals with charcoal is greater than at the metallurgical works of the South Ekaterinslavsky, in the Donetz district, and during the crisis of 1905 when the market price of pig iron dropped, a great many of the Ural works had to close. During the last few years, owing to the extraordinary industrial development of Russia, there was a great demand for iron, the price nearly doubling, and now pig iron is practically unobtainable at any price. The indiscriminate cutting down of the forests for charcoal-making during the last two centuries, and the new forestry laws which have forbidden the cutting of young trees, has brought about a crisis which either entails the construction of new railways to transport timber for charcoal from hitherto inaccessible forests, or the finding of a suitable coking coal. Several attempts have been made in connection with briquetting and coking peat, which is abundant in the Urals, but so far no works are in operation. Lignite has, however, been successfully mixed with English coke and used at the Bogoslovsky in smelting copper.

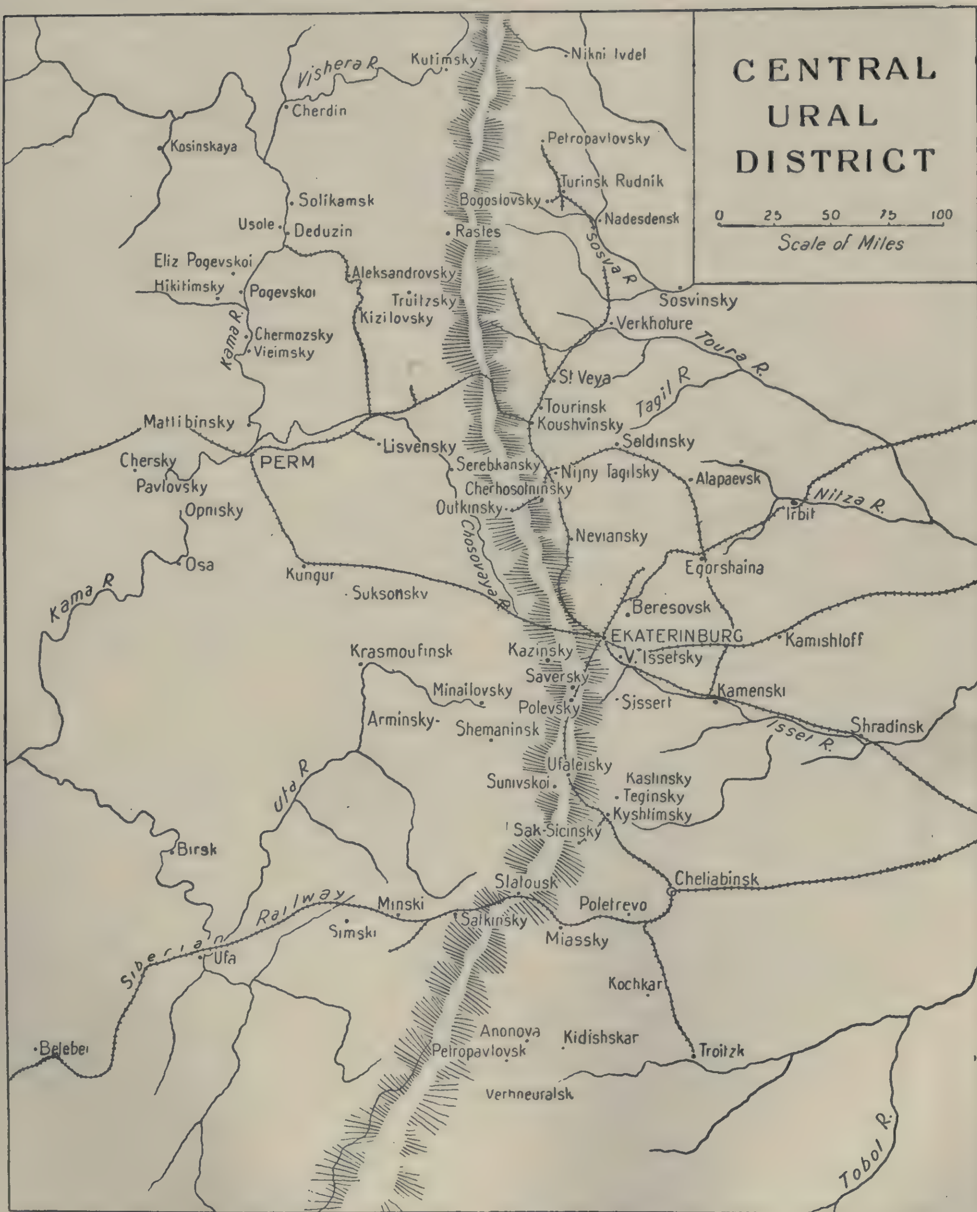
A large quantity of steel rails is produced at the Ural works which, to a large extent, supplies the railways existing and in course of construction. The quantity of machinery manufactured is also yearly increasing, although it is chiefly of the heavier and more primitive type. The manufacture of electrical machinery, cutlery, and steel tools, though there is a big demand, is non-existent; the reason for this lies in the fact that money is so easily made in other branches of industry that no one has yet been found who can afford to tie up capital for a short period of unproductiveness while plant for such undertakings is being erected. Every year more inclination is being shown to spend money on new industries, both by Russians and foreign capitalists, and the war has given a great impetus. One of the greatest obstacles to this development has been removed by the present war by the cessation of business with Germany, which dumped quantities of manufactured goods, especially cheap cutlery, into Russia. No doubt a Sheffield will arise in the Urals in the near future.

The following figures will show the production of pig iron during the period 1907 to 1914:

Year	Pig iron in tons
1907	619,000
1908	577,000
1909	561,000
1910	628,000
1911	721,000
1912	839,125
1913	902,262
1914	856,382

COPPER.—In the early history of copper smelting in the Urals the Tourinsky mines, situated in the Northern Urals, belonging to the Bogoslovsky mining property, were famous. These mines have been worked almost continually since the middle of the eighteenth century. The average assay of these lodes at the surface is stated to have been about 15% copper. The copper content fell the deeper the lodes were mined, as shown by the following figures: Year 1800, copper content 8·5%; year 1821, copper content 5·4%; year 1861, copper content 3·9%.

Interest in the copper deposits of the Urals of the present day is, however, centred in the pyrite lode which stretches parallel with the summit of the Ural range from Kyshtim in the south, where it was at first discovered, through the mining properties of Ufaleisky, Sissert, and others to Revdinsky, near Ekaterinburg. Beyond the copper is traceable still farther north to near Bogoslovsky. The content of these sulphides in comparison with that of the old oxidized lodes, such as the Bogoslovsky, is less, averaging from about to 2 to 3% against the 10 to 15%. They are, however, worked at a depth of several hundred feet, as against surface workings of the oxidized deposits, because



of their gold and silver content and modern improvements in smelting. The search for these deposits by means of diamond drilling is now being carried on actively. The indications as a rule consist of a so-called 'iron cap,' containing traces of copper, gold, and silver. Two important lodes have been discovered and good tonnages of ore developed recently, the Degtiarsky on the Sissert property, and the Kalatinsky lode on the Verh Isetsky. As a result of finding these pyrite deposits, starting with Kyshtim, the production of copper in the Urals nearly doubled in the four-year period of 1908-1912. We may look forward to the day when Russia will become self-supporting in this respect. The import duty on copper of £32 per ton makes the sale of the metal in Russia an extremely lucrative business.

The following table shows the output of copper in the Urals, detailing each works:

Works	1913 Poods	1914 Poods
Pishminsky	85,006	107,934
Kalatinsky	building	65,936
* Polevsky	81,186	60,465
Voesky	86,765	77,404
* Kyshtim	485,722	480,274
* Bogoslovsky	250,594	229,955
Total	989,273	1,021,968
British equivalent	15,956 tons	16,483 tons

* British capital involved.

PLATINUM.—Platinum is a mineral which may rightfully be called a Ural mineral, as nearly 95% of the world's output is produced in the Ural region, Colombia and Canada being responsible for the remaining 5%. Although platinum has been traced in the Urals practically from the north to the south, production comes mainly from two districts. The two most important workings are those on the Tagil property, and the group on the rivers Toura and Iss, belonging mainly to the French company (Anonyme) and to Count Shouvaloff. Although all the metal so far produced has been from washing the alluvium, it has been proved that the old river gravels and alluvium derived their metal from dunite and olivine rocks locally present. The platinum is closely associated with chromite stringers running through the dunite rock. During the current year the Tagil Mining Administration, having tested pannings of crushed chromite matter, found that owing to their high platinum content, as also to the frequent occurrence of the stringers, it would probably pay to treat the whole bulk by crushing in a Chilean mill and washing. With the object of putting this to the test, a plant of about 50 tons per day capacity has been erected, and experiments are being made. The platinum content of the whole mass of rock is roughly estimated at about 1½ dwt. per ton, so that with the high prices at present ruling such an experiment looks promising. In any event the value of the rock will be determined. As the occurrences of the stringers in the dunite are irregular, although frequent, it is unlikely that it would pay to pick them out by sorting and crushing separately. Previous attempts elsewhere to treat the rock direct failed to show a profit, but the present is undoubtedly an unusually favourable opportunity to test the matter on a large scale without loss.

Platinum was first mined at the beginning of the nineteenth century, but it is only within the last 40 to 50 years that its real value was recognized. It was formerly used in the Russian coinage. This has long since been discontinued. The output of the metal is represented by the following figures: 1909, 214,042 oz.; 1910, 184,753 oz.; 1911, 192,976 oz.; 1912, 184,767 oz.; 1913, 158,084 oz.; 1914, 156,755 oz.

Primitive methods of recovering platinum consisted of washing by tribute in sluice-boxes. Russian peasant women carted platinum bearing sands to sluice-boxes. Of late years, however, tribute work is gradually becoming curtailed and dredging taking its place. The latter form of working is more satisfactory from the point of view of preventing the stealing of the metal, which is practised wholesale when tributers are at work, as, owing to the large area over which they work, it is almost impossible to keep them sufficiently under control.

GOLD.—Gold in the Urals is found and mined from quartz veins in the limestone and metamorphic rocks, from alluvium and old river beds, and in conjunction with copper from the sulphide ores. In the Kochkar region, which contains the best known gold deposits, the gold-bearing quartz veins intersect a granite belt, itself containing gold in a free state; and again near Ekaterinburg it occurs in small quartz stringers cutting through a huge granite lode called beresite.

In the upper levels of the quartz veins the gold is free. As greater depth is attained, the free gold gets less frequent and gradually it is found only in the pyritic matter. Such quartz veins containing gold are found throughout the Urals. The old river beds and alluvium have been worked by tributers. The quartz veins, with few exceptions, have only had serious attention from the miner recently. The working of the alluvium entailed little or no capital outlay, a tributer's outfit hardly costing more than £5, whereas now, with the exhaustion of the more accessible alluvial workings except those suitable for dredging methods, quartz mining has unavoidably been taken up and is taking the place of the alluvial workings.

The gold output of the Urals during the last few years has been: 1911, 256,770 oz.; 1912, 222,176 oz.; 1913, 217,644 oz. These amounts are small, being little more than those of platinum, and is considerably less than it was 25 years ago.

The few gold dredges which have been erected have met with great success, and the encouraging results obtained will have much to do in getting more capital and energy into the field. The Russian Government, especially of late years, has done much to facilitate gold mining, in some cases granting loans and subsidies to deserving companies. Ural placers are usually credited with being small as compared with the enormous deposits of Western and Eastern Siberia; this, however, is not exactly the case.

ASBESTOS.—This mineral, although of frequent occurrence in the Urals, is only mined commercially in the Bajanova district (30 miles from Ekaterinburg) where six companies are engaged in this business; the production is yearly increasing, as will be shown by the following figures: Year 1910, 13,129 tons; 1911, 11,872 tons; 1912, 16,584 tons; 1913, 16,661 tons; 1914, 13,587 tons.

Asbestos is nearly always to be found in the Urals where there are large masses of serpentine. A new discovery has recently been made and many claims staked in the Northern Urals. Formerly asbestos miners were largely dependent on foreign markets. Now, however, a new market is developing in Russia.

OSMIRIDIUM.—In conjunction with platinum, osmiridium is mined in the Ural mountains chiefly in the Miass mining district, to some extent in the Kyshtim mining district, and also in the North Ekaterinburg mining district. It is found in small quantities in alluvial placers with platinum and gold. Its production is small, not being more than two poods during the last 10 years, but 15 years ago 15 to 20 poods were mined annually. In Ekaterinburg the price rarely falls below £12. 12s. per oz. The reported production during the year 1914 was only 2·4 ounces.

PRECIOUS STONES. — Emerald, topaz, amethyst, chrysoberyl, aquamarine, and other precious stones are mined in the Urals. The emerald deposits belong to the Cabinet of the Emperor, and are situated 50 miles in a northeast direction from the town of Ekaterinburg. These deposits were discovered in the year 1831, and between that date and 1862, 142 poods (2·29 tons) were mined. In the year 1897 a concession for the exclusive exploitation of these deposits was granted to a French company. The fact of a concession being granted does not prevent a large business being done by the peasants stealing the stones from the mines and selling them to merchants in Ekaterinburg, who by the way are excellent cutters. Excellent work is done also by the grinding and polishing works belonging to the Tsar, as also by local merchants, in hornstone, malachite, jasper, serpentine, and other rocks. Ornaments of great value and artistic taste are produced at these works, and are to be found adorning the cathedrals of Europe.

FUEL.—As has been stated, the slowness of the fuel development has become one of the vital questions in connection with the mining and metallurgical industry of the Urals. Charcoal was used in iron smelting during the last 200 years, which caused little attention to be paid to development of coal mines. Another great difficulty has been the absence of railways, a difficulty rapidly being overcome. The annual coal production of the Urals of to-day is about 1,200,000 tons, but this is not sufficient to cope with the present demand, not to mention future increases. The Dounovsky and Kisellefsky collieries are the chief producers, the latter being responsible for 65% of the total. Since the present war and the difficulty caused by congestion of traffic and absence of rolling stock, greater activity is apparent in prospecting for coal, and most important of all a good coking coal is looked for to take the place of metallurgical coke formerly imported from Germany and England. In some isolated cases in smelting copper lignite has been used, mixed with foreign and South Russian coke in the proportions of 25 and 75%. Many tests also have been made with the extensive peat bogs, but with little success.

New coalfields, which are attracting the recent attention of the prospector, are the Cheliabinsk, where most of the big mining companies have claims, and the Poltavsky, in Orenburg, through which the new railway, Orsk-Troitzk, is to run. The reports by Russian geologists on the latter coalfield are optimistic. If expectations are realized the production of this district should reach large figures at an early date, as its situation, 146 miles from the station of Polevaya on the main Siberian line, until the Orsk-Troitzk railway is finished, makes it possible to supply, not only the Urals, but also the central Russian and Southern Siberian districts.

OTHER MINERALS.—The Outka oilfield is in the most isolated part of the Northern Urals, in the Petchora district, and its inaccessibility is the chief cause of the slowness of its development. With the construction of the Archangel-Bogoslovsky railway, capital may be spent advantageously on its development.

The mining of pyrite for the sulphur content, has increased rapidly since the present war, and the cessation of the import of this mineral from Spain and Portugal. Prospecing has shown the presence of large deposits near Ekaterinburg, and several sulphuric acid works are being hastily erected.

Graphite, wolfram, and quicksilver are known to exist, and have reached the stages of the prospector's production.

THE CRYOLITE MINE AT IVIGTUT, GREENLAND

By CLINTON P. BERNARD

Cryolite, the double fluoride of sodium and aluminium, is used as a solvent for alumina in the manufacture of aluminium. The only deposit worked is in Greenland. The author has recently paid a visit of inspection.

THE only known commercial deposit of cryolite occurs at Ivigtut in Arauk Fjord, South Greenland. Most mining engineers are familiar with the deposit through specimens of the mineral, but few have visited the locality. Not only is the deposit interesting from the fact that this unusual mineral is found in great quantity, but also because it is one of the finest examples of an ore deposit in a pegmatite.

Open-cut Mine at Ivigtut.

Greenland, while not a well known country, has been extensively explored from a mineralogical standpoint. Many rare minerals have been found, some of which are not known to occur elsewhere. The inhabited portion of the island is a narrow strip of land along the south and west coasts, varying in width from 15 to 150 miles, and lying between the sea and the great ice-sheet. This strip of coast, in the southern part extremely rugged and mountainous, is everywhere indented by fjords. The scenery is magnificent. The sea and mountains have been brought together, yet retain the charm of both. Peaks 6000 to 7000 ft. high rise almost perpendicularly from the water's edge. There is no timber and very little vegetation. The Esquimaux live on the products of the sea.

Cryolite was first made known to Europeans by Greenland Esquimaux in 1798. They called it "rock that smells," and were accustomed to grind it to a powder and take it as snuff. Exploitation began about the year 1852, a Danish chemist having discovered a method of producing soda and aluminium from cryolite. For many years a steady production was maintained, and though the value of the material as a source of soda is now negligible, the enamel industry still makes its production profitable.

Cryolite occurs in a small area of porphyritic granite enclosed in older granitic gneiss, as a large irregular mass. Originally at the surface it formed an elongated outcrop about 150 metres long and 30 metres wide, with a northeast–southwest axis. As the deposit was opened it was found to be much larger than the outcrop indicated. It broadened and dipped under the country rock to the east. The boundary in this direction is marked by a pegmatite vein in which a number of rare minerals have been found, including ivigtite and columbite, while cassiterite and molybdenite are also present. The cryolite is of pegmatitic origin. In mining, two grades are recognized, the 'white' and 'black'. The 'white' contains about 90% to 95% cryolite, the remainder being pyrite, galena, and siderite. The mineral of this grade is shipped to Copenhagen. The 'black' contains beside the above impurities a large amount of fluorite.

VIEW SHOWING THE OPEN-CUT MINE, THE SHIPS THAT ARE LOADING, AND THE PILES OF CRYOLITE.

This grade is shipped to Philadelphia, and is valued at about $20 per ton.

Mining has been by open-cut. Until recently primitive methods were used, but in the last few years dynamite has replaced gunpowder, an air compressor and drills have been installed, and a modern double-drum hoist operates cages in a steel shaftway placed on the side of the open-cut. A curiously antiquated method of handling the product is practised. After being shot down, it is shovelled into barrows after hand sorting, dumped on a platform, washed, and shovelled into cars. The cars are hoisted and trammed to a wooden platform. Here the mineral is dumped on a pile, the larger pieces being used to build a wall, and the wall laid to line. The cryolite is worked into the pile to avoid air spaces, and the top carefully levelled. The accompanying illustration shows some of these piles which are about 30 ft. wide by 100 long. The main reason for making these piles is that the cryolite may be measured by the Government's representative, the concession being granted on a tax based on the number of cubic metres shipped per year. The scale of the taxes at present is given in the table printed on the succeeding column.

Cubic metres per annum.	* Kroner per cubic metre.
White Cryolite:	
Up to 4000	120
4000—7000	90
7000—8000	100
8000—9000	110
Additional Output	120
Black Cryolite	48

* One kroner is about 1s. 1d. or 26 cents.

Production in 1914 amounted to 4612 tons of 'black' cryolite shipped to Philadelphia, and about 12,000 tons of 'white' cryolite to Copenhagen. On this production the Government tax amounted to about Kr. 550,000.

Communication during the spring is hazardous because of the ice. The first ship from Europe usually arrives in April, while the last vessel leaves about the first of November. As a consequence during four or five months of the year the mine is completely isolated. Forty to fifty men are employed the year round, but during the summer this number is increased by fifty or sixty brought by the first vessel in the spring. These extra men leave by the last boat in the autumn.

Exploitation of this deposit has been a success from the start, and conservatism in adopting a less cumbersome method of handling ore is largely due to this fact.

CORNISH MINES DURING 1915.

By B. ANGWIN.

HEREWITH is a table analysing the output, revenue, costs, etc., at the chief Cornish mines. By reason of the diversity of methods employed in segregating the costs of the various mines as exemplified in their published reports, it is a difficult matter to so arrange the various items that a comparison can be made. However, it may be of interest to have these returns tabulated with as great a degree of similarity as possible. In considering these returns there are one or two points of dissimilarity in the various properties that should be remembered. Thus the lodes worked at Levant and Wheal Kitty are small; that is, their widths are rarely sufficient to fill an ordinary level, necessitating the miners working in a cramped position, or otherwise taking out some worthless ore. All the other mines have large lodes. Again, East Pool, South Crofty, and Carn Brea, in their ore treatment departments, are faced with extra cost by reason of their complex ores necessitating magnetic separation, not required in the other mines. In the pumping department, Dolcoath and Grenville use three of their shafts, Carn Brea two shafts, while East Pool, South Crofty, Levant, and Wheal Kitty do all their pumping through one shaft each. Dolcoath alone has adopted electric pumps, which have been installed in one of their three pumping shafts.

Dolcoath's crushing is done in two batteries, one containing steam-driven Californian stamps, the other electrically-driven Holman's pneumatic stamps, and the first concentration being achieved through the aid of Frue vanners. East Pool's crushing is done by a steam-driven battery of Holman's air-cushion or pneumatic stamps, the concentration being done (after classification) by means of Bewick - Moreing's converted Wilfley tables for the roughs, and Frue vanners for the fines, with magnetic separation after calcination. South Crofty's crushing is carried out in an electrically-driven battery of Californian stamps, the concentration being done (after classification) by means of Buss tables, with magnetic separation after calcination. At Carn Brea the crushing is effected in two separate batteries; one consisting of steam-driven Cornish stamps, the product being concentrated in Cornish buddles; the other consisting of 2 Nissen stamps and 5 Californian stamps,

	Dolcoath		East Pool		South Crofty	
	Tons	Yield per ton treated	Tons	Yield per ton treated	Tons	Yield per ton treated
		lb.		lb.		lb.
Ore treated	83,070		81,426		70,790	
Concentrates produced:						
Tin	1,186·75	32	724·2 (Tin and Wolfram)	19·9	629·92	20·1
Wolfram					97·55	3·09
Copper			819·67 (Copper and Arsenic)	23·6	311·55	9·85
Arsenic					660	20·88
	£	s. d.	£	s. d.	£	s. d.
Receipts for Tin, or Tin and Wolfram	110,908·2	26 8·5	73,042·43	17 11·2	69,527	19 7·61
Receipts for Copper and Arsenic			11,331·14	2 9·48	13,334·55	3 9·2
Total Receipts	110,992·35	26 8·9	84,687	20 9·6	94,958·2	26 10·07
Total Costs	110,346·7	26 6·9	85,659·2	21 0·4	80·041·75	22 5·67
Profit	645·6	1·9			14,916·45	4 4·4
Loss			972·2	2·8		
Total Costs itemized:						
Pumping			9,021·8	2 2·59		
Mining			25,012·6	6 1·73		
Hauling	102,952·8 (Pumping to Development)	24 9·3	3,705·8	10·9	72,140·25 (Pumping to Development)	20 4·5
Ore Treatment			27,069·5	6 7·78		
Development			10,754·8	2 7·7		
Royalties	7,393·9	1 9·3	2,619·3	7·72	3,282·2	11·2
General Expenses					4,619·3	1 1·97
Development	301·5 fathoms		645·5 fathoms		588·3 fathoms	

electrically driven, the product (after classification) being concentrated on Card tables, with magnetic separation following after calcination. At Grenville there are two steam-driven batteries of Cornish stamps, their products being concentrated by means of Frue vanners. Levant's crushing is done in one steam-driven battery of combined Californian and Cornish stamps, the concentration being effected by means of Cornish buddles. At Wheal Kitty crushing is done in one steam-driven battery of Cornish stamps, the concentration being done by Cornish buddles.

Unfortunately Basset's returns were not published in time for this issue. The Tresavean is a private concern and details are not given. No figures are available for St. Ives Consolidated, West Kitty, or Geevor.

The recent rich strike at Agar has quite thrown in the shade the strikes of good ore reported at both Tresavean and Basset, which as yet have not been sufficiently followed to warrant a definite estimate. In regard to the strike of ore at Agar, the Chairman's estimate of 1500 tons of black tin being in the block of lode at present practically uncovered, and ready for stoping at an early date, is, in the opinion of local men, well within the mark. This portion of the lode covers only 170 ft. in length along the strike, while the property at this point is about 5000 ft. wide along the line of the lode. The yield of 35 lb. per ton promised from this source is a conservative estimate.

Wheal Agar is a very old mine, originally rich in copper from which the adventurers reaped an abundant harvest. But between the years 1847 to 1896 the public provided £140,000 in calls, receiving only £42,000 in dividends. They then got tired, and resolved to cut their losses. East Pool, on the other hand, between the years 1834 and 1896, for a sum of £3193 from the adventurers, had given in dividends over £500,800. At that time the two mines had each a pumping engine, but in the event of either of these engines stopping it was considered that the other mine also would be flooded. It was at this juncture that Mr. James Holman stepped into the breach, and took over the responsibility from the owner to keep the Wheal Agar engine going. Subsequently he so imbued the committee and the adventurers of East Pool with his optimism that they resolved to take over the lease of the Wheal Agar property. Thereafter the two mines were worked by one company. In 1913 Bewick, Moreing & Co. provided additional capital, and the cost-book system was abolished for limited liability. Before this firm decided to undertake to finance and manage the mines, they sought the advice of Dr. Malcolm Maclaren, who made a geological examination with the object of ascertaining the best lines for exploratory work. The discovery of the new parallel lode was the result.

Carn Brea and Tincroft		Grenville		Levant		Wheal Kitty	
Tons	Yield per ton treated	Tons	Yield per ton treated	Tons	Yield per ton treated	Tons	Yield per ton treated
	lb.		lb.		lb.		lb.
59,488		46,298		25,059		17,978	
608·95	22·9	546·7	26·24	395·65	35·3	206·75	25·7
				181·1	16·7		
£	s. d.	£	s. d.	£	s. d.	£	s. d.
59,310·9	19 11·2	50,653·5	21 10·5	35,487·6	28 3·8	19,402	21 7
				2,098·6	1 8		
68,654·75	23 0·9	52,416·1	22 7·7	39,642·3	31 8·6	19,736	21 11·4
67,364·3	22 7·7	63,284·8	27 4	40,206·1	32 1·5	20,845·3	23 2·2
1,290·45	5						
		10,868·7	4 8·3	563·8	4·9	1,109·3	1 2·8
5,882·6	1 11·7					1,784·3	1 11·8
21,649·7	7 3·3					7,536·6	8 4·6
		63,138·15	27 3·3	31,915·25	25 5·6		
25,588·6	8 7·2					5,946·2	6 7·3
5,797·3	1 11·3					2,195·9	2 5·3
2,471·8	10	146·65	0·7	951·95	9·1	351·2	4·7
5,973·2	2 0·2			7,392·9	5 10·8	3,031	3 4·4
400·5 fathoms		261 fathoms		325·7 fathoms		358·6 fathoms	

STUDIES OF JOPLIN ORE DEPOSITS

By H. FOSTER BAIN.

The Joplin district is one of the world's great zinc-producing areas. The ores occur in relatively undisturbed sedimentary rocks free from igneous intrusions. Their origin has been in dispute, but Mr. Siebenthal's work would seem to set at rest all doubts and to justify the conclusion of the members of the United States Geological Survey in 1900 that the Joplin ores belong to the type primarily formed by cold uprising artesian waters, a type that must hereafter be taken most seriously.

JOPLIN is "the town that Jack built, 'jack' being the Missouri miners' name for sphalerite or zinc-blende. It is to the occurrence of large deposits of 'jack' under and around the city that Joplin owes its existence. It is a hustling modern place, built in the middle of an open prairie country diversified by beautiful woodlands along what once were clear streams. Now the streams are muddied with tailing, as in all great mining regions, and many of the trees have fallen to the axe, for even 'untimbered' mines make heavy demands upon the forest when the output is large. The Joplin district, a somewhat indefinite term, includes southwestern Missouri and adjacent parts of Kansas and Oklahoma, in the heart of the great middle west farming country of the United States. It is an area of fertile soils, and little disturbed sedimentary rocks. Neither mountains nor intrusions of igneous rock are to be seen, and yet the district is one of the great metal-producing areas of the world. It has been estimated that from 1850 to 1914 the mills yielded 6,430,000 tons of zinc concentrate and 1,216,000 tons of lead concentrate, having a combined selling value before shipment to the smelters of about £53,200,000. In 1915 there was added to this 312,450 tons of zinc concentrate and 45,000 of lead concentrate, with a combined value of over £5,300,000. By way of comparison it may be noted that in 1913, the last complete year before the war, the Broken Hill mines yielded 398,759 tons of concentrate containing 47% zinc, equivalent to 187,416 tons of spelter. In the same year the Joplin district was credited with 290,670 tons of zinc concentrate, including blende and 'calamine' ores, equivalent to 152,600 tons of spelter. Working conditions are so easy that extremely low-grade ores may be mined, and in 1913 more than 9,000,000 tons of crude ore was produced to yield the concentrate noted. Taking account of both the lead and zinc mines in Missouri, 12,300,000 tons of ore, with an average recoverable metal content of only 1·6%, according to the figures of the United States Geological Survey, was mined in 1913. In normal times ores are mined in the Joplin district of which the value in the ground is less than eight shillings per ton. With the high prices now ruling crude ore containing one per cent of zinc, or possibly less, may be worked. Despite the growing output of mines in other parts of the United States, Joplin continues to be the most important zinc-producing district in America. Temporarily its ores are even at a premium since the sulphide concentrate averages more than 58% in zinc and only 2·2% iron, and constitutes the bulk of the output. The importance of this at a time when smelting capacity is badly wanted, is evident.

A mining district so important and in which the occurrence of the ores is so unusual has, naturally, attracted much attention from students of ore deposits. There has recently been published a modest little volume* in which is summarized the evidence and conclusions bearing on the genesis of these ore-bodies which have accumulated in the course of 15 years' work by various members of the staff of the United States Geological Survey. Since the Joplin ore deposits illustrate a type the validity of which has been much in dispute, and since it was my good fortune to have been intimately connected with the beginnings of the studies of which Mr. Siebenthal's book constitutes the summary, I may be permitted to review the matter at some length.

The Joplin deposits occur upon the southwest flank of the Ozark uplift, a broad low structural dome occupying the southern half of Missouri and adjacent parts of the neighbouring states. As this dome is approximately 350 miles in its longest diameter, north-east-southwest, and 250 miles at right angles to that direction, and as the central portion is only 750 to 1000 ft. above the plains which surround it, it will be seen it is not a striking topographic or structural feature when compared with mountain regions in general. In its present aspects it represents a warped

* 'Zinc and Lead Deposits of the Joplin Region, Missouri, Kansas, and Oklahoma,' by C. E. Siebenthal. *U.S. Geol. Survey, Bull.* 606, Washington, 1915

peneplain probably not older than the Cretaceous and is marked by a radial drainage. Near its eastern end is an area of Pre-Cambrian crystalline rocks around which outcrop concentrically the Paleozoic sedimentaries up to and including the coal measures of the Upper Carboniferous, known there as the Pennsylvanian. The major area of outcrop over the Ozark uplift is occupied by Cambrian and Ordovician dolomites and sandstones. Outside them is a thin encircling band of rocks, largely shales, representing partly the closing stages of the Devonian and partly the earliest Carboniferous. Then follow the non-magnesian limestones and flints of the Lower Carboniferous or Mississippian. These rocks reach up on the earlier beds in a long wide tongue covering the southwestern part of the uplift, and it is in them that the principal bodies of zinc ore occur. Beyond these limestones is an encircling body of Pennsylvanian coal measures, beginning usually with a black shale and resting, in most places, unconformably on the limestones as is true over much of the Mississippi valley. In the Joplin region outliers of the shale, representing erosion remnants, occupy hollows in the surface of the Mississippian, here known as the Boone limestone. These hollows were formed in the erosion interval represented by the unconformity and enlarged later by solution. There are beds intermediate in age between the Boone and the black shale of the Joplin district at various points along the east and south edges of the uplift, and a few remnants of these are found in the sink holes in the ore-producing districts. Where the Mississippi embayment cuts into the uplift on the southeast, Eocene beds come into contact with the Paleozoics, but that is far outside the area in which the ores occur. The orebodies, excluding derived products, consist of blende, galena, pyrite, marcasite, dolomite, and jasperoid, in broken and dissolved non-magnesian limestone and flint, and along the edges of the black shale inliers, penetrating the latter slightly. There are a few accessory minerals, but the association is simple and markedly different from that of the complex sulphides in the silver-lead ores of the western states.

In 1900, to go back no farther, there were two theories of the origin of these deposits. Most of those who had studied the matter believed the ores to have originated through the decay of the sedimentary rocks and the concentration of the minerals, essentially as residual deposits, in the sink holes, with incidental penetration of the surrounding rocks. Mr. Arthur Winslow, then recently the state geologist of Missouri, had formulated this view with great exactness and backed his arguments with a formidable mass of detailed observations. Another group, influenced possibly by general notions of ore deposition resulting from studies in other fields, held the Joplin deposits to be but peculiar and markedly irregular masses of ore formed by ordinary processes associated with heated waters ascending at some time in the past from underlying crystalline rocks. This view was supported vigorously by Mr. W. P. Jenney in particular, he having spent many months in the study of the deposits of the region. There were minor variants on each hypothesis urged by various individuals, but in general Winslow and Jenney represented the two schools of thought among students of these ores.

In February 1900, Mr. C. R. Van Hise read before the Washington meeting of the American Institute of Mining Engineers his remarkable paper on 'Some Principles Controlling the Deposition of Ores.' In that paper, he suggested, on the basis of a brief study of the Wisconsin zinc deposits, that these ores of the Mississippi valley had been formed by a 'first concentration' due to uprising artesian waters forming a part of the normal cold water circulation of the earth's crust, and that they had later been re-concentrated by a 'second' downward local circulation as erosion overtook the beds. At the time I had recently completed, in consultation with the late Samuel Calvin, a survey of the lead and zinc deposits of Dubuque county, Iowa, and after considering the possibility of the deeper artesian waters of the region having entered into the making of the ores, had rejected the hypothesis. Van Hise and I were soon in friendly but vigorous correspondence over this phase of the matter, and I argued against him so stubbornly that, when the opportunity came a few months later, he invited me to take up the study of the Joplin deposits under his direction. He felt confident, from his reading of the literature, that his hypothesis would be found to apply, and I was unconvinced but open to conviction. We met at Joplin, and it soon became clear to both of us that the burden of evidence would be upon anyone disputing the artesian hypothesis. After a few days he left me to work the matter out, at the same time that Mr. G. I. Adams, under direction of Mr. Bailey Willis, undertook the necessary stratigraphic studies and mapped certain nearby portions of North Arkansas. Mr. E. F. Burchard

GEOLOGIC MAP OF THE OZARK UPLIFT, SHOWING MINING DISTRICTS, AND RESERVOIRS FROM

WHICH ZINC AND LEAD BEARING SEDIMENTS WERE OBTAINED. ACCORDING TO C. E. SIEBENTHAL.

assisted Mr. Adams. We spent four months in the field and then three more in the office and laboratories at the University of Wisconsin, submitting our results early in February 1901. They were printed in part 2 of the twenty-second annual report of the United States Geological Survey, and Van Hise and I prepared a general summary which was published in the Transactions of the North of England Institute and also those of the present Institution of Mining Engineers.

We satisfied ourselves, and some of our readers, that the ore deposits represented concentrations of material disseminated through the country rock, mainly the sediments, and were formed by a double concentration, the first being due to artesian waters at ordinary temperature feeding mainly in the Cambro-Ordovician rocks up slope and secondarily perhaps in the Pre-Cambrian crystalline rocks, thence passing down under the area and up into the Mississippian rocks along fractures and faults that in the Joplin area cut through the Devono - Carboniferous shale that elsewhere forms a bar to such uprising currents. In the Joplin area the shale appeared to be not only thinner than farther south and east, but different in character, more brittle and hence likely to yield by fracture to stresses that would not have sufficient force to break across the usual black shale. The first concentration was followed by a second when downward flowing waters made their way into the rocks as one result of the erosion now going on in these regions. This reconcentration took the forms of oxide, residual, and sulphide enrichment and examples of each were given. Neither then nor later has anyone been able to formulate a set of criteria which will permit invariable discrimination between the ores of the 'first' and those of the 'second' concentration. This is all the more difficult since artesian waters still rise into the ore-bearing beds and, presumably, are still building ores of the 'first' concentration.

Following these preliminary studies, Messrs. W. S. T. Smith and C. E. Siebenthal were assigned by the United States Geological Survey to map in detail the Joplin quadrangle. This they did with great patience and care, publishing in 1907.* Early in the work Mr. Siebenthal determined the fact that I had over-estimated the frequency and the amount of the faulting in the area and in a most interesting paper published in 1905† he set the matter straight. It happens that the Boone formation is much alike through most of its thickness, so that considerable faults, both horizontal and vertical, might well exist and escape detection. Where, however, in what have proved in the main to be erosion and solution channels, the Pennsylvanian shale was let down into the limestone, it is not uncommon to find flexed beds, slickensides, shearing, and breaking of the hard rock, and other of the common evidences of faulting. There are places where the border is so sharp, and its course so well maintained for considerable distances, that with full recognition of the extent of the unconformity, it still seemed natural to consider the major displacement due to faulting. It appeared that the shale had been let down in long narrow graben or by means of parallel faults. In fact such things do occur, and Mr. Siebenthal has described, with evidence that cannot be gainsaid, the Seneca fault, which extends from near Joplin many miles southwest into Oklahoma. In general, however, the displacement proves to have been small, and the evidences of actual movement are mainly due to secondary slumping. The old channels cut deep into the hard limestone and are tortuous and winding. Being filled with soft shale, they formed belts of weakness, along which such later stresses as occurred were relieved before they accumulated sufficient force to do more than fracture and slightly displace the beds. Thus Mr. Siebenthal's observations afforded an explanation of the most puzzling feature of the faults as we had mapped them in 1900, namely, their non-persistence and failure to fall into any system or pattern. It may also be noted that it would not require much of a stress to crack the thin and brittle shale separating the Mississippian from the Cambro-Ordovician dolomites under Joplin, and so permit a mingling of the circulations in the two sets of beds.

About the same time that Mr. Siebenthal began his work at Joplin, the late E. R. Buckley, who had succeeded to the position of State Geologist of Missouri, entered the field. He was assisted by Mr. H. A. Buehler, the present State Geologist. Messrs. Buckley and Buehler took up the study in particular of the Granby area, which lies a few miles south and east of Joplin proper. They became convinced that there was no faulting, that the artesian waters of the deeper beds had nothing to do with the origin of the ores, and that the segregation of the ores "from the first to the *nth* concentration" was by down-

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* Joplin district folio (148) *U.S. Geol. Survey*.
† 'Structural Features of the Joplin District,' *Econ. Geol.*, vol. 1, pp. 119–128.

ward flowing waters deriving their supply of metals principally from the Pennsylvanian shales that formerly overlay the area. They argued the matter at length* with much ability and some pertinacity.

The matter is of considerable scientific interest as it involves the competence of artesian circulations, and of economic importance since it goes to the heart of the questions relating to the possible occurrence of deeper runs of ore. Messrs. Buckley and Buehler recognized this phase of the matter, and stated as regards the case for the artesian waters and with relation to the possible occurrence of ores in the Devono - Carboniferous shale: "If this were the case, it is hard to conceive why uniformly throughout the district the deposits do not occur in this portion of the formation." Their conclusions were accepted by Mr. E. Haworth and his associates of the Kansas Survey,† who furthermore undertook to measure the amount of water flowing into the mines to determine whether or not there was an artesian flow present, and if so what its quantitative importance was. They found that, making all allowance for rainfall and runoff, the amount of water pumped from the tract measured was 10 to 15% more than could have come from local sources, but held that this was unimportant; an inference open to some question.

Meanwhile Mr. Siebenthal continued his studies, and contributed from time to time short papers on various phases of the work, particularly regarding the waters of the artesian wells in and around the mining region, and the newer mines that were being opened in Oklahoma under the edge of the protecting Pennsylvanian shale. This was a situation where, according to the artesian theory, large orebodies were to be expected, but where they are difficult of explanation otherwise, and such mines continued to be developed. Deep drilling at Granby also proved the presence of an important and persistent orebody at the horizon of the underlying shale; the particular position where, according to Buckley and Buehler, it should not occur. In 1900 when I was at Granby, there was already one drill hole that had penetrated this horizon and, while the amount of evidence afforded by the cuttings was slight, it was so clear and so characteristic that it had seemed even then to warrant expectation of finding workable ore at this lower horizon.

* 'Geology of the Granby Area,' *Missouri Bureau Geol. and Mines*, vol. 4, 1906.
† 'Special Report on Lead and Zinc, Kansas.' *Univ. Geol. Survey*, vol. 8, 1904.

All these matters are now cleared up, and it may be hoped set at rest, in the volume that Mr. Siebenthal has given us. He shows beyond question that there is an important influx of artesian waters and by studies of their character he explains the chemical difficulties that have stood in the way of their acceptance by some as important in ore deposition. Mr. Edwin T. Hodge, for example, had concluded after elaborate compilation of analyses of deep well waters that rain water passing into the earth would become first acid and then neutral and finally alkaline, in which condition it would not contain in solution any metals other than the alkalies and alkaline earths. This had been hailed as a strong argument against the ability of meteoric waters to produce large sulphide deposits. Mr. Siebenthal points out that attention has been too much concentrated upon possible transportation of the metals as sulphates and upon acidity of underground solutions in terms of the strong acids. He shows, using Mr. Chase Palmer's method of classification, that in fact the waters involved are alkaline saline, being dominated chemically by salts of the alkali metals, but also holding in solution hydrogen sulphide and carbon dioxide. He shows by analysis and by actual test that such waters will dissolve and transport lead and zinc, and that upon escape of the carbon dioxide the metals will be precipitated as sulphides by reaction with the hydrogen sulphide. He also determined the presence of the metals in the deeper artesian waters of the region and in the light sediment that accumulates in reservoirs in which such waters are stored at the surface. He shows therefore not only the theoretical possibility of the process, but demonstrates that it is actually in operation at the present time. The only possible question that it would seem could be raised is as to its quantitative efficiency, and as to this the facts of the occurrence in the field, as contrasted especially with the non-occurrence of the ores in situations similar as to structure and geological history but lacking in opportunity for outflow of the deeper artesian waters, would seem sufficient.

Mr. Siebenthal's work does not alter materially the main conclusions reached at the close of the first field season, but it does amplify and reinforce them with a wealth of detail that lights up the dark places and gives most welcome precision. With the knowledge Mr. Siebenthal sets before us, and to which it is impossible to do full justice in the space here available, it is possible to direct prospecting with much greater surety than had long seemed probable. He is able, for example, to discriminate the Devonian phase of the general shale horizon from the Carboniferous. The Devonian is represented by the Chattanooga, a black shale patchy in distribution and impervious to the uprising solutions save where cut by a major break such as the Seneca fault. Ore, therefore, is to be anticipated along and under the edges of this shale, just as similar bodies are being developed under the edge of the later Pennsylvanian shale at Miami in Oklahoma and in the Picher Lead Company's mines in southeastern Kansas. The Carboniferous shale occurring at the same horizon and present where the Chattanooga is absent, is thinner, more brittle, and much less impervious. It is this which underlies the Joplin area proper, and Mr. Siebenthal presents structure maps showing how the uprising waters are concentrated in this immediate area. Wider results of Mr. Siebenthal's work include an explanation of the segregation of copper and iron mainly in the central part of the Ozark uplift, with zinc deposits along the outer border, and lead predominantly in the middle zone. In discussing these and similar phases of the great problem of ore deposition, he has shown much ingenuity and penetration, and he has marshalled an enormous array of detailed facts.

These facts place the theory in a position where no intelligent student of ore deposition can hereafter fail to include it among his working hypotheses when beginning the study of a new deposit. In its application mistakes will doubtless be made from time to time, as when Mr. Siebenthal leans too heavily, as it seems to me, on the theory in discussing the fluorspar veins of southern Illinois and western Kentucky, but as to the validity of the artesian hypothesis in general, and its application to the Joplin region, he will be a valiant knight indeed who attempts to establish a new order.

METHODS OF SHIPMENT OF DIAMONDS FROM KIMBERLEY.

We give herewith some notes relating to the method of shipment of diamonds from Kimberley. At present the mines, of course, are not being worked, though washing has been resumed. The methods of dealing with the diamond output are, however, not changed or likely to be changed.

The entire production of the De Beers Co. is sold through a London syndicate which maintains a local agency at Kimberley. To this agency the De Beers Co. hands the unsorted parcels, usually each day. On receipt of the parcels the agency has them sorted into the various grades. On the accumulation of a sufficient amount of sorted goods a shipment is made to the London office of the syndicate. Each lot of diamonds is wrapped in the special paper used by diamond houses for the purpose. The lots are then placed in a light tin box having dimensions of about 4 by 10 by 14 inches. The cover of the box, which is a close fit and of the same depth as the box, is then slipped on, and the package, without sealing, is wrapped in stout paper. It is then bound carefully with thick cord, which is secured to the package at a number of points by wax stamped with the seal of the local Government detective agency. The parcel is then delivered to the local post office, where it is entered as an ordinary registered parcel.

In the procedure above described a certain number of Government regulations must be observed. All transfers of diamonds from one person to another, or from one locality of the district to another, must be announced to the local Government detective agency. The purchase of uncut diamonds by other than regularly licenced dealers is prohibited. Before a shipment of diamonds can be made, the sender must go before a justice of the peace and make a sworn affidavit covering the source of the diamonds and the amount of the shipment. The detective department is then notified and the package before being closed is submitted to their inspection for verification of the sworn statement. The package is then closed in the presence of one of the Government detectives, who seals it with the stamp of his office.

The risk of loss sustained by the diamond syndicate is covered by an open insurance policy with Lloyd's, which is stated to cost 2s. 6d. per £100 of goods, and covers the risk from the receipt of the diamonds from the De Beers Co. to their delivery into the hands of the London office of the syndicate. At the end of the year, if no loss has been sustained, 10% of the amount paid in insurance is refunded. Notification to the insurance company of shipments is sent by mail at the time of shipment. The liability of the Government in carrying diamond shipments through the mail is merely nominal in amount, being the same on diamond shipments as on any other registered parcel.

DISCUSSION

'Mineralization in Malaya.'

The Editor:

Sir—Your February issue contains a letter from Mr. J. B. Scrivenor, Government Geologist to the Federated Malay States, a small part of which is devoted to a criticism of a few statements in the first part of my article on 'Mineralization in Malaya,' which appeared in your October number, but the greater part of which is devoted to matters of a more personal nature. Scientific discussions are generally characterized by the absence of personal matters, and it is a matter of regret that Mr. Scrivenor should have deviated from this excellent custom. His complaint (which he should have made to the Federated Malay States Government and not in the pages of a Magazine devoted to *mining* matters) is that when I was his assistant I should have placed before him my arguments against his glacial theory of the 'Origin of the Tin-Ore Deposits of Kinta District' before leaving Malaya, and he wishes to know why this was not done.

The reason seems to be clear from Mr. Scrivenor's letter to the Magazine, in which he writes: "Mr. Jones said he was unable to comply unless I gave him three weeks for field-work in Kinta, which I had to refuse on account of other work; . . . . for the rest of his term of office Mr. Jones was working at high pressure." Quite so! I certainly did not ask for too much time, for in the refusal to my appeal to be allowed time to bring before him my arguments, which I regarded of the *utmost importance* in their bearing on the geology of Ulu Selangor, which I was then mapping, Mr. Scrivenor wrote on September 3, 1914: "Three weeks might not prove enough. I first saw the Kinta clays in 1903." It is admitted I was very busy, that I did not ask for too much time, and that no time was granted. When, therefore, was I expected to write a very important paper which, if my interpretation was the correct one, would disprove the 'Glacial Theory' and shatter the conclusions to which my superior officer had come after ten years of hard work? I had on many occasions, in conversation, drawn attention to serious evidences against his theory, but always with the same result.

Before leaving Malaya early in March I was able, during my private time, to examine the few important mines in Kinta I had hitherto not seen and to write some rough notes on the subject. My thesis on the 'Origin of the Supposed Glacial Tin-Ore Deposits of Kinta District' was not, however, completed until after I had visited, on my way to England, the Girideh coalfield in India to see the 'Talchir Beds' with which Mr. Scrivenor had correlated the Kinta 'glacial clays,' and had worked at it for some weeks at the Geological Department of the Imperial College of Science. So much remained to be done on this work that I was unable to hand it to the University of London until the latter part of June, in spite of their regulations, which stated that if not sent in before the end of May the result could not be announced for some months. This actually happened in my case, for I was not informed that my thesis had been accepted until late in October.

But surely it is quite out of place to ask for this information, and to indulge in innuendoes, in the columns of a high-class publication read by people desirous of obtaining technical and scientific knowledge on points of common interest. If Mr. Scrivenor has cause to complain, he should, even as a matter of duty, place the whole matter before the proper authorities.

Mr. Scrivenor refers to a letter I sent him (a private one) in which I stated that I had read a paper before the Geological Society on the origin of the tin-ore deposits of Kinta and had made it the subject of my thesis for the Doctorate of Science. That is so; in other words, my views were placed before the highest tribunals available before writing a *single word* to any Magazine, or paper, on the subject. That, I submit, was the best course possible to a geologist who had absolute faith in the correctness of his interpretation. No mention is made that this letter contained, in view of what I had done, an appeal to Mr. Scrivenor to allow my three years' work on the geological map and memoir of the 'Geology and Mining Industry of the Ulu and Kuala Selangor' to be published. He had repeatedly, by word of mouth and in writing, given me to understand that it was to be handed over to the Government Printer, but after my return to England I was informed, in answer to my letter on the subject, that he had decided not to publish it but to *incorporate some of it in a memoir which he hoped to publish about eighteen months hence!* This notwithstanding that the memoir and the geological map are very important to the development of Ulu Selangor, for the junction of the granite and the mica- and tourmaline-schist has been there traced for over a hundred miles, and with the exception of a stretch of eight miles, tin-ore is shown to have been proved *in situ* the whole way, frequently in workable amounts.

I raise no objections to quotations from a private letter nor from an office copy, typed by a young native clerk, of a 'Preliminary Report on Mining in the Main Range' written for the Chief Secretary, and not for publication. They will both bear the light of day. I would ask Mr. Scrivenor, however, when referring to that Report to give me credit for drawing his attention, for the first time, to the intensity of mineralization at Gunong Bakau and its neighbourhood, and to its economic importance. In his memoir on Ulu Pahang (page 24), published in 1911, he states "that a *summit* about 4700 ft. high on the State boundary, separating the Ulu Chinchong in Pahang from the Ulu Bakau in Selangor, is formed of a white rock that looked like the Chinchong rock without cassiterite. . . . The amount of this quartz-topaz rock appeared to be considerable, and although the stone is of *no value* it is interesting in that it points, if indeed it be correct to assume that the Chinchong rock is an alteration product, to there having been in this part of the granite magma a large quantity of free hydrofluoric acid capable of attacking felspar with the precipitation of a previously combined base, *such as tin*" (italics inserted, W.R.J.).

Mr. Scrivenor was in England for the greater part of 1912; in 1913 he read my report; and in 1914 he wrote a paper on 'The Topaz-Bearing Rock at Gunong Bakau' in which the following occurs: "The prospectors were finally rewarded by finding the topaz and *cassiterite*-bearing rock *in situ* close to the top of Gunong Bakau, and it was proved later to extend to the Selangor side of the mountain and *up to its summit*." This rock is now being worked for tin-ore in two mines.

If, as is now explained in his communication to the Magazine, he meant that the quartz and topaz were valueless because he knew "no one would buy either mineral," then his first description of that rock in which occurs the phrase "without the precipitation of a previously combined base such as tin" was very misleading. Would he describe a quartz reef, carrying a good percentage of gold, as being of no value because there is no market for quartz?

The only evidence advanced in his communication against my reasons for forming the opinion that the lodes at Gunong Bakau are not horizontal is that, on Mr. Bibby's land, a vein "has been followed for about 300 ft. almost horizontally. It then rises slightly." In your October number I gave two photographs (Figs. 5 and 6) of an actual lode at the entrance of one of the longest of these horizontal adits which clearly show that the lode has a considerable dip. A horizontal drift, without knowledge of its relation to the dip and strike of the lode, does not convey much as to its disposition. If, however, these lodes

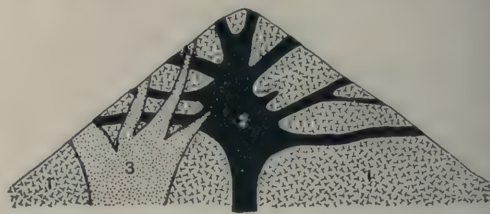


Diagram showing the relations of the porphyritic granite to the two intrusive rocks. (1) Porphyritic granite, (2) Quartz-topaz rock, (3) Topaz-aplite. The central quartz-topaz vein has not been proved to exist as yet.

are horizontal, why did Mr. Scrivenor figure them in fifteen different directions in the diagram, reproduced herewith from his paper on this locality, published in the *Quarterly Journal* of the Geological Society for December, 1914? This diagram, besides showing that the veins are represented as very much *not* "horizontal and parallel," also shows the rock at the summit, described in 1911 as of no value, as the outcrop of a quartz-topaz rock carrying tin ore.

I am asked for my reason, through the columns of a Magazine published in London, why I did not include a description of the topaz-bearing rocks of Gunong Bakau in my memoir, written in Malaya, on Ulu and Kuala Selangor. Does it not strike Mr. Scrivenor as decidedly unfair to ask me this question *now*, after he had reported favourably to the Chief Secretary on the memoir a few days before I left for England? And has he forgotten that he asked me not to describe them, as he had *already* done so in two publications, his memoir on Ulu Pahang, and his paper in the *Q. J. G. S.* mentioned above?

In quoting my remarks on the 'differentiation of granite magma' at Gunong Bakau, Mr. Scrivenor seems to have missed my point. That the veins were intrusive in the granite is quite clear, but what I contend is that when being intruded into the fissures in the consolidated, or partly consolidated granite, this magma was *not then topazized*, but became topazized by mineralizing gases, which also carried tin (probably here as tin fluoride), while the magma, which now had been intruded, was consolidating. This seems to have been clearly put in my article on 'Mineralization in Malaya,' where it is stated "that the veins appear to be intrusions, during the later phase of the main igneous intrusion, of the acid differentiation products of the granite magma; and that the topaz and cassiterite are the result of the action of tin fluoride on felspar, the tin fluoride first attacking water vapour to form tin oxide which was deposited, and the hydrofluoric acid evolved attacking the alumina and silica of the felspar to form topaz." I submit that, unless one accepts Mr. Scrivenor's new theory, it is scientifically incorrect to speak of the 'intrusion of quartz-topaz rock.'

The origin of the topaz in the Gunong Bakau rocks is of great interest, and I have recently written a paper to the *Geological Magazine* in which I endeavour to show that the reasons which Mr. Scrivenor puts forward in support of its primary and against its secondary origin bear another interpretation; and it is pointed out that these rocks have striking resemblances in their mode of occurrence, and mineral content, to those occurring in the Erzgebirge tinfield, where development work has clearly proved the topaz and cassiterite to be of secondary origin. A copy will be sent (when published) to Mr. Scrivenor, and I shall await his reply with interest.

WILLIAM R. JONES.

Geological Department,
Royal School of Mines, S.W.,
March 30.

Labour Problems in Zinc Smelting.

The Editor:

Sir—Your editorial on this subject in your last issue greatly interested me, though my experience causes me to disagree with some of the views expressed. Permit me to add a few remarks.

When speaking of the zinc difficulty we naturally understand it to refer to the treatment of the flotation concentrate produced at Broken Hill. Its fine granulation presents many difficulties to present roasting methods. Also the roasting of blende is not so easy of successful accomplishment as the roasting of pyrite, nor are the furnaces suitable for the latter serviceable for the former. As to the running of the sulphuric acid plant by a gang of 'blacks,' you admit that the plant was skilfully and economically worked, so that the blacks were really skilled workmen. Skill is familiar knowledge of any art, combined with dexterity in the practice of it; things may be run without skill, but the question arises, is it profitable?

The introduction of mechanical means does not necessarily imply the best solution of a difficulty. It may reduce labour, but it may not reduce the ultimate cost. What may be good practice at one place may not be the best procedure in another. To give an example: The De Place hand-worked furnace is employed in Europe for roasting blende, and the mechanical Hegeler in the United States. In America they have cheap fuel and expensive labour. They economize in the latter and pay less attention to fuel consumption. In Europe the reverse holds good, but the net result is that the 'all in' figure for roasting in Europe by the De Place is less than the Hegeler, with richer gases for the manufacture of acid, and a better roasted product to boot. The following comparisons may be of interest:

	De Place	Hegeler
Number of men required.........	8	13
Pounds of blende per man	2750	3815
Coal consumption	12%	25%
Power................................	—	40 hp.
Cost of plant per ton capacity.	£100	£312

The amount of acid made from blende in England, as compared with that produced from pyrite, is negligible; in Belgium and Germany the figure is at least 50%. In Belgium the sulphuric acid people roast the blende for the zinc distillers much on the same lines as they handle Spanish pyrite in this country, the distillers paying about 5s. per ton bounty.

In modern gas-fired retort furnaces the labour is concentrated at the producers, and the manœuvre over, no labour is required at the furnaces except for the regulation of the distillation and drawing of metal, so that the 24 hours' shift may be considered a thing of the past.

The introduction of mechanical devices for charging and discharging would be of material advantage, provided that the plant was of sufficient size to justify the expenditure. With the flotation concentrates two difficulties present themselves in charging: (1) The very fine ore sticks to the augers, and this necessitates frequent cleaning during the charging; (2) tendency of the retorts to blow out and danger to the workmen.

Mechanical charging is not so universal in the United States as the article might lead one to believe, and briquetting of the roasted material is much more desirable. In either case we get about 20% increased capacity of the furnaces, which means not only a saving in charging labour, but reduced distillation costs.

The more general use of pyrometers would also be a step in the right direction, yet, all the same, successful and economical work still depends on the exercise of proper judgment both by men and the management; the procedure cannot be made automatic or the personal equation eliminated.

As regards the zinc troubles in this country, the difficulties will not be overcome by simply 'wishing,' and the Broken Hill companies will naturally be desirous of finding people who can offer the best terms; and those willing in this country to treat these concentrates will have to be given some assistance to enable them to compete with other countries more favourably situated than our own, otherwise it will be a case of 'as you were.' The labour question is not the only stumbling block.

By the middle of the current year the Japanese will have a plant at work capable of handling 40,000 tons yearly of Broken Hill concentrates.

W. DEWAR.

London, April 3.

MINERAL PRODUCTION IN ONTARIO.

The preliminary report on the mineral production of Ontario during 1915, prepared by Mr. T. W. Gibson, Deputy Minister of Mines, contains the following tabular statement:

	Quantity	Value $
Gold, oz.	411,588	8,501,391
Silver, oz.	23,730,839	11,742,463
Copper ore, tons	271	4,418
Copper in matte, tons	19,608	3,921,600
Nickel in matte, tons	34,039	17,019,500
Iron ore, tons	394,054	764,515
Pig iron, tons	493,400	5,910,625
Cobalt ore, tons	177	21,464
Cobalt, metallic, lb.	111,588	103,746
Cobalt oxide, lb.	314,906	254,447
Nickel, metallic, lb.	11,905	4,762
Nickel oxide, lb.	145,323	17,968
Other cobalt and nickel products, lb.	75,447	9,227
Molybdenite ore, tons	192	12,859
Molybdenite concentrate, lb.	1,068	1,240
Net value metallic production		47,721,180
Non-metallic products		9,811,664
Total value mineral production		57,532,844

As compared with 1914, the gold, copper, and nickel show increases. The increase in gold production is due chiefly to the expansion of operations at Porcupine, and that of copper and nickel to the demands on Sudbury resources for munition manufacture. On the other hand, the yield of silver at Cobalt shows a decline.

The producing gold mines in Ontario in 1915 were seventeen in number, twelve being in Porcupine. Some of the large producers were:

	Tons Milled	Ounces Recovered	Value per ton $
Hollinger	334,750	156,575	9·67
Dome	317,740	73,726	4·79
Acme	106,486	49,933	9·69
McIntyre	101,955	36,094	7·31
Porcupine Crown	46,419	29,032	12·92
Tough-Oakes	26,196	26,658	21·04
Vipond	35,899	11,871	6·83

Other gold producers were: Dome Lake, Gold Reef, Schumacher, Porcupine Pet, Mines Leasing Co. (Rea), Porphyry Hill, Croesus, Canadian Exploration Co., Cordova and Olympic.

The production of silver by districts was:

	Oz.	Value $
Cobalt proper	23,187,545	11,481,265
Casey township	223,939	105,846
Gowganda	242,229	116,856
Silver from gold ores	77,126	38,496
	23,730,839	11,742,463

Nine companies each produced over 1,000,000 oz. in 1915:

	Oz.
Nipissing	4,610,051
Mining Corporation (Townsite)	2,776,589
Kerr Lake	2,109,355
Seneca Superior	2,109,355
Coniagas	1,996,257
Mining Corporation (Cobalt Lake)	1,566,206
Temiskaming	1,486,400
La Rose	1,071,694
McKinley-Darragh-Savage	1,061,827

As to the future of Cobalt, there is little doubt that the decline in output which began in 1912 will continue.

The quantity of nickel-copper ore raised in 1915 was 1,325,973 tons. The ore smelted by the Canadian Copper Co. and Mond Nickel Co. was 865,169 and 407,144 tons respectively.

SPECIAL CORRESPONDENCE

CAMBORNE.

GRENVILLE.—The account issued for the six months ended December 31 last shows a loss of £4766, or 4s. 1d. per ton milled. The tonnage crushed was 23,088 tons, as compared with 23,210 the previous half-year, and the production was 254 tons of tin concentrate, a yield of 28·8 lb. per ton. The receipts totalled 27s. 1·5d. per ton, and the working cost was 27s. 10·7d. per ton of ore milled. This is presumably a lower figure than would be the case if a profit was being earned, for no dues are payable when there are no profits, and the local rate assessment is based on the amount of royalties actually paid in the previous half-year. The development was 853 ft., or 1 ft. for every 27 tons milled, which is insufficient in a mine of the character of Grenville. If, when large profits were being earned a year or two since, the development of the mine had been more vigorously prosecuted, it is more than likely that this unfortunate position would have been avoided. However, the position should be speedily improved, as Fortescue's shaft has been sunk to the 395-fathom level, and the level west is to be pushed with all speed to intersect the main shoot, while the higher price now ruling for tin is more than sufficient to turn the loss into a profit if the sales are maintained. Investigations are being conducted by a representative of the Board of Agriculture and Fisheries of the granite deposits in the mine with a view to ascertaining if potash can be manufactured therefrom on a commercial scale.

SOUTH CROFTY.—Many people say that this property is the best managed mine in Cornwall. Certainly everyone admits that the mine has been handled with commendable skill and foresight, with the result that although it is a low-grade complex proposition, it is today the only mine in Cornwall able to show a sufficient margin of profit to admit of a dividend being paid. The profit earned for the year 1915, after allowing £2640 for depreciation of plant, was £3790, and to this has to be added the sum of £1882 transferred from the insurance reserve account, as the company no longer proposes to run its own insurance fund against employers' liability for accidents. The dividend for the year was 10% which, in these abnormal times, must be regarded as eminently satisfactory. The following comparative figures are culled from the report:

	1914	1915
Tonnage milled	69,842	70,790
Production:		
Black tin	644 tons	628 tons
Wolfram	113 "	98 "
Arsenic	707 "	660 "
Yield per ton:		
Black tin	20·66 lb.	20·10 lb.
Wolfram	3·63 "	3·09 "
Arsenic	22·67 "	20·88 "
Value per ton:		
Black tin	16s. 9·26d.	16s. 9·52d.
Wolfram	2s. 8·27d.	2s. 10·19d.
Arsenic	3s. 0·42d.	3s. 8·15d.
Working cost per ton	20s. 7·10d.	20s. 11·71d.
Development	3993 ft.	3530 ft.
Development ratio per ton milled	1 ft. for 17½ tons	1 ft. for 20 tons

It is anticipated that the western continuation of the lode recently discovered in the Agar section of East Pool will be found within the northern boundary of the South Crofty sett, but if not it should run through North Crofty, which is also owned by the company, while a lease of the intervening sett of Trevensen has been acquired on reasonable terms. The possibilities of the future have therefore been considerably enhanced by the foresight of the management in acquiring these setts, and already Captain Josiah Paull has commenced cross-cutting from Robinson's shaft at the 180 and 225-fathom levels to intersect the new lode, but as the distance to be driven is considerable, it will be many months before the lode will be reached.

TORONTO.

TAXATION OF MINING COMPANIES.—The first effect of the announcement by Sir Thomas White, Finance Minister, of the proposed tax of 25% on all profits of mining companies over 7% was to depress mining issues and divert American capital from contemplated investments in the Porcupine and other Northern Ontario mining districts. In several cases negotiations for the purchase of mining properties were suddenly broken off, and it looked as if a serious blow had been given to the mining industry. The strong opposition to the new tax on the part of the mining and industrial interests has since resulted in the modification of some of the most objectionable features of the measure. The Finance Minister announced that in estimating the profits of mining enterprises an allowance would be made for the decrease of capital by the exhaustion of the ore reserves, and profits would be calculated on the basis of the actual money investment instead of the nominal capital. These and other changes have rendered the bill as acceptable as any measure of taxation could reasonably be expected to be, and have tended to a renewal of confidence in mining investments.

PORCUPINE.—The output of the Dome for February was $163,480, from the milling of 32,040 tons, an average yield of $5·10 per ton. Ore has been struck in the new central shaft below the 625-ft. level, although the position of the shaft was chosen so as to avoid sinking in ore. The results obtained by deep diamond-drilling at the Hollinger are being confirmed by development. A winze now down to the 1275-ft. level is in rich ore at this depth after passing through a porphyry formation, where the gold content was considerably less. The new central shaft has been concreted down to the 425-ft. level. A ball-mill has been put in place for the treating of ore from the Acme. Two veins have been encountered in a cross-cut at the 425-ft. level. The new vein on the 400-ft. level of the Vipond has been followed for 165 ft., and proves the best so far opened on the property, carrying $13 to the ton. The Dome Lake mill has been closed to allow of the installation of the new cyanide plant, which is expected to be in running order by the end of the month. Work has been commenced at the West Dome, and development will be actively undertaken as soon as the spring has fairly set in. At the McIntyre an accident in No. 5 shaft has postponed the starting of the 150-ton addition to the mill, which will increase the total milling capacity to 450 tons per day. Sinking will shortly be resumed on the North Thompson. The shaft will be sunk from the 300-ft. level to 500 ft., and new levels opened. Plans for a new mill are being considered. At the Porcupine Crown the mill is averaging about 125 tons of ore per day and much low-grade ore is being developed on the upper levels. Higher grade deposits are being opened on the 700-ft. level.

KIRKLAND LAKE.—Operations in this district will be greatly stimulated by the furnishing of electric power by the Northern Ontario Light & Power Co., which is expected early in the summer. The Teck Hughes will install a 12-drill compressor and a cyanide plant of 50-ton daily capacity in readiness for the completion of the power line. The Tough Oakes mill is treating about 120 tons daily, and the February production is estimated at about $45,000. The Beaver Consolidated is developing the McCane property under an option, and has sunk to the 200-ft. level, where a station is being cut. The Wright-Hargraves claim, to the east of the Tough Oakes, which is very rich on the surface, is being developed.

BOSTON CREEK.—The development of the property of the R.A.P. Syndicate has met with encouraging results. A drift at the 100-ft. level has disclosed a rich ore-shoot, varying from 4 to 10 in. in width, carrying much free gold. The Miller Independence has installed machinery and begun sinking a shaft. The Crown Reserve has the four McCrea-O'Neil claims under option. In a test pit at a depth of 10 ft. the vein is 10 in. wide and rich in free gold. This district is likely to attract a good deal of attention during the coming season.

COBALT.—The flotation process is exciting interest at present. Tests conducted at the Buffalo have demonstrated that Cobalt ores can be successfully treated by flotation, and the company has decided to install a 600-ton flotation plant immediately for the treatment of tailing. The McKinley-Darragh is also adopting the system and is installing a 150-ton plant guaranteed to save 500 oz. per day by higher extraction. The ore reserves of the McKinley-Darragh are estimated at 1,875,000 oz. The Nipissing during February mined ore of an estimated net value of $171,856 and shipped bullion from Nipissing and custom ores of an estimated net value of $309,320. The Gifford-Cobalt has unwatered the main shaft, and is diamond-drilling from the 200-ft. level to determine the size of the orebody, which is believed to be an extension of the Beaver vein system. The annual report of the Seneca Superior shows that the property is nearly exhausted. The production for the year was 2,047,000 oz., and the reserves are estimated at between 400,000 and 450,000 oz. The company had on hand ore to the value of $194,000 and $132,766 cash. The annual report of the Right of Way showed receipts of $56,835, operating expenses $44,582, and net profit $12,252. The balance on hand was $13,188.

THE NICKEL SITUATION.—The movement in favour of compelling all nickel ore produced in Canada to be refined in the country is making headway every day. The matter has been before Parliament several times during the present session, and the Government has plainly intimated that as the International Nickel

Co. had promised to establish a refinery in Canada of sufficient capacity to satisfy all Imperial requirements, there was no intention of imposing any restrictions on the exportation of nickel ore. Nevertheless the agitation is continued, and latterly the question has been taken up by the principal Liberal newspapers which had previously been silent or lukewarm. The Government is being steadily assailed for its attitude in tolerating the monopoly of the International Nickel Co. which, it is alleged, is overcharging the Imperial Government for nickel, which it supplies at a much cheaper rate to the United States Steel Corporation. The Liberals evidently see their opportunity to make a political issue of it by taking advantage of the prevailing war excitement to charge their opponents with indifference at a time of crisis to Imperial interests.

TAVOY, BURMA.

The output of wolfram ore during 1915 increased by nearly 30% over 1914. The total of 2115 long tons has, once more, to be recorded as the highest of any other district in the world. Practically the entire amount is won from a mineral belt which is about 56 miles in length by 7 miles wide. Thanks to drastic action by the Government of Burma, strenuous efforts are being made to increase the monthly yield of wolfram to five hundred tons. The tonnage shipped in the first week of January totalled 86 long tons. Some tin is contained in the concentrate, and this is separated in England. Molybdenite has not yet been discovered in payable amounts.

The Lieutenant Governor paid Tavoy a visit early in December, and stated every possible effort must be made to get a large increase. Concessions would be instantly taken away unless such effort were made. Coolie labour would be provided, and extra officials would deal with them and assist mine owners in all possible ways. The coolies are now arriving at the rate of from 300 to 500 weekly, and a total of 3000 will soon be in, thus raising the labour force to about 6000. Unfortunately no notice was taken of expert advice that trained men should be imported from India, with the result that Chinese agricultural coolies are being supplied to work in mines and on alluvials. The mine-owner has to pay nearly £8 per head and can recover only £4.

The leading Rangoon firms are now represented locally, and have absorbed all available miners, but their needs are not half satisfied. The Government states that Australian and Cornish miners will be imported, but it is obvious that this cannot be done. Concessions are being given liberally, roads are being feverishly constructed, rest-houses appear along these by magic, and the weekly steamer imports motor-cars in numbers.

In spite of the efforts of the newly appointed Warden of Mines and the Inspector, who was recruited from the Geological Department of India, no attempt to improve on the objectionable 'tribute' system is to be made, unless the mine-owner so desires, on account of the demand for the ore and from lack of trained mine foremen. The system helps the untrained owner, but is entirely detrimental to the industry, as all systems which are based on neglect of the future and which ignore 40% of the mineral content must inevitably be.

What may prove to be a real advance towards better mining lies in the death by consent of the Lower Burma Chamber of Mines. Phœnix-like it arises as the Tavoy Chamber, which has ample funds and should do good work. No magnetic separator has yet been installed, nor can interest therein be aroused. The need is less than formerly, seeing that the clean-ore area of Hpaungdaw is getting most of the development just now. Some of the older mines in other parts are showing signs of exhaustion.

SAN FRANCISCO.

CALIFORNIA'S Mother Lode region, in the foot-hills of the Sierra Nevada, is considerably cheered by the re-opening of the famous old Eureka mine, closed for forty years. Mrs. Hetty Green of New York, the thrifty and eccentric dealer in first-mortgages and other sure things, was prevailed upon at last to part with the mine for a sum said to be in excess of $500,000. The syndicate formed for taking over the property includes L. D. Ricketts of Arizona, Ambrose Monell of the International Nickel Co., T. F. Cole the copper magnate, W. E. Corey, and several associates of these financial leaders; John B. Farish, mining engineer, is managing director, and T. Walter Beam, a veteran mining man, of Colorado, is resident manager. The mine, known locally as Hayward's 'Old Eureka,' is at Sutter Creek, in Amador county. It has been under water, of course, for many years, and the first thing done will be to pump out the extensive old workings. A new shaft may be found necessary. With the aid of modern methods of mining and metallurgy, so much improved since the early '70s, when the mine produced $15,000,000, it is hoped to find and treat enough ore to return the purchase price, the cost of re-opening, which will be at least another $500,000, and more or less profit.

THE NORTH STAR AND EMPIRE mines at Grass Valley, between which an apex suit had raised points of difference, have settled the questions amicably by a compromise. The basis of settlement, as arranged by Curtis H. Lindley and William E. Colby for the North Star Mines Co. and W. H. Dixon for the Empire Mines & Investment Co., is an equal division of disputed territory, the different areas being appraised in accordance with the various geological and legal factors pertaining to each. Ross E. Browne and Fred Searls, Jr., were among the geological specialists consulted.

THE ANACONDA company's activities in metallurgical development have been given publicity by recent articles by Professor L. S. Austin of Salt Lake City, in the *Mining and Scientific Press*, and by the paper by Messrs. Frederick Laist and Albert E. Wiggin, metallurgical engineers for the Anaconda company, to be read before the Arizona meeting of the American Institute of Mining Engineers. Anaconda's practice in underground mining at Butte is criticized sometimes for being old-fashioned and under the influence of labour-unions, but no one denies the excellence of the metallurgical work done at Anaconda, where most of the Butte ore is reduced to copper. The re-modelling of the milling plant to include flotation on a tremendous scale is one of the striking results of the recent changes. Incidentally, machines of both the Minerals Separation and Callow types are used in the flotation mill; the former are found to give a clean tailing, the latter a clean concentrate; hence the latter are used for cleaning the concentrate previously separated. Another feature is the coal-dust firing of reverberatory furnaces. The use of finely pulverized coal, charged longitudinally into furnaces 143 ft. long, resembles the burning of producer-gas. The zinc-reduction works of the Anaconda company to be built at Great Falls has attracted much attention. This plant is to cost $2,000,000 and is expected to produce 36,000 tons of zinc per year by the newly perfected electrolytic precipitation process. The initiative of the Anaconda company in taking this step has influenced operators in other districts to experiment with electrolytic zinc, but it is recalled that conditions as to power, technical staff, and grade of ore, are rather more favourable with the Anaconda company than with others, so that in spite of the high price of zinc, a word of caution is necessary. [We give elsewhere abstracts from the paper by Messrs. Laist and Wiggin. Professor Austin's article mentions that the Callow plant is used for re-treating middling from the Minerals Separation machines, though Messrs. Laist and Wiggin make no mention of this.—EDITOR.]

MEXICAN affairs are changing too rapidly to permit of safe predictions. What can be said applies, incidentally, to the American attitude toward recent entanglements with European governments as to Mexican troubles. The two factors that determine the foreign policy of the United States are President Wilson and the temper of the American people. Both have been incredibly lenient to Mexico and to her unfortunate population; but both are nearing the end of their patience. Because the United States is big and wealthy and not easily disposed to war, she has given foreign nations the benefit of all doubts. But the doubts are becoming rather too numerous. If the American people get aroused for war either for invasion of Mexico or against the abuses of any European nation, the government at Washington will not be backward in acting quickly and effectively.

Of course, the chief question now is as to whether Villa will be caught soon. If he is not captured at an early date, it is probable that the Mexican government will ask the American expeditionary force to withdraw. Such withdrawal would mean another fiasco like the one made at Vera Cruz, and it is doubtful whether the American people would endure humiliation a second time. Most assuredly, if the expedition were to fail in its object, and be then withdrawn, Mr. Wilson's chance of re-election as President would disappear. In short, the outlook is serious, for the reason that this expeditionary force may prove to be the forerunner of an army of intervention. Of course, all the mining men are hoping that it may be so, particularly those in Northern Mexico, where a change of government, or rather, a change of flag, would be of immediate economic benefit. Indeed, the rumour has been circulated that the United States has expressed willingness to pay $300,000,000 for all that part of Mexico north of a line extending westward from Tampico, but this was denied promptly at Washington. Meanwhile, the American Smelting and Refining Co. has withdrawn all its employees from the various smelters in Northern Mexico, and other mining companies have had to suspend operations, where, in some cases, they had only lately been resumed.

PERSONAL.

JOHN ADAM has been appointed manager of the Great Fingall Consolidated, West Australia.

LIEUTENANT G. B. ATKINSON, formerly attached to the British Embassy at Petrograd, is in London.

H. FOSTER BAIN, editor of *The Mining Magazine*, arrived at Cape Town on April 5, proceeding to Johannesburg and other important mining districts of the Union of South Africa, Rhodesia, and the Congo, where he proposes to secure first-hand information for the preparation of a series of articles.

R. W. BROCK is Major in the 72nd Battalion Seaforth Highlanders of Canada.

JOHN CADMAN, professor of mining in the Birmingham University, succeeds Sir Boverton Redwood as president of the Institution of Petroleum Technologists.

J. C. CAIN has been appointed chief chemist for the new works erected at Huddersfield for British Dyes, Limited.

W. McC. CAMERON is expected in London from Johannesburg.

FREDERICK G. CLAPP is in charge of the petroleum division of the Associated Geological Engineers, and has his office at 120 Broadway, New York.

ELI T. CONNER has removed his office to 26 Liberty Street, New York.

E. P. COWLES, formerly with the Princess Estate & Gold Mining Co. on the Rand, has received a commission with a Tunnelling Company of the Royal Engineers.

A. SPENCER CRAGOE has been appointed consulting engineer and general manager to the Cornish Wolfram Mines, Ltd., a subsidiary of the Continuous Reaction Company, Ltd.

ROBERT E. CRANSTON is now in charge of the gold mining department of the Anaconda Copper Mining Company.

T. D. CUNNINGHAM left London on April 1 for South Africa on his return to the Verdite mine in the Barberton district.

EDWARD F. FINNIS has joined the metallurgical staff of the Broken Hill Associated Smelters, Limited.

DONALD F. FOSTER is here from the Sukari mine, Egypt.

R. M. GEPPERT has returned to London after his visit to the Esperanza mine, El Oro, Mexico.

T. W. GIBSON, Deputy Minister of Mines for Ontario, has arrived in England on business connected with the Ontario Nickel Commission.

H. A. GUESS has been appointed managing director of the mining department of the American Smelting & Refining Company.

F. H. HAMILTON has gone again to Canada in connection with the financing of the North Thompson mine at Porcupine, Ontario.

J. A. LEO HENDERSON read a paper on the Natural Gas Industry before the Institution of Petroleum Technologists on March 21. He has since left on a visit to the United States and Canada.

R. L. HERRICK, at one time a valued contributor to the defunct *Mines and Minerals*, has joined the staff of the *Engineering and Mining Journal*.

E. HIBBERT has a commission with the 48th Highlanders of Canada, and is serving in France.

SIR THOMAS H. HOLLAND is Chairman of the Royal Commission which has been appointed to investigate the economic resources and industrial possibilities of India.

R. KANDA has been recently in French Indo-China.

C. B. KINGSTON was recalled to the witness-box to give further evidence for the defendants in the case of Amalgamated Properties versus Globe & Phœnix. He left for South Africa on March 18.

R. N. KOTZE, Government Mining Engineer for the Union of South Africa, has made a rapid recovery after a severe operation.

DAVID H. LAWRANCE is in London from San Antonio, Lower California, Mexico.

G. F. LAYCOCK has received a commission in the Royal Engineers, Tunnelling Section.

DONALD M. LIDDELL, recently chief assistant editor of the *Engineering and Mining Journal*, has joined the technical staff of Merrill, Lynch & Co., 7 Wall Street, New York.

G. MACFARLANE has left for West Africa on business for the Wallis Company.

J. MALCOLM MACLAREN is making an examination of the Oriental Consolidated Mining Company's properties in Korea, and expects to be there for some months.

W. W. MADORE, of the Durban Roodepoort Deep, has obtained a commission with the Royal Engineers, Tunnelling Section.

S. C. MAGENNIS has returned from Burma.

F. P. MENNELL was in the witness-box for ten days, giving evidence for the Amalgamated Properties of Rhodesia, in the law-suit against the Globe & Phœnix Company.

W. A. NEILL has joined the engineering staff of the Dorr Cyanide Machinery Company.

C. T. NICHOLSON is here from the Federated Malay States.

CAPTAIN PETER N. NISSEN, Royal Engineers, has been here on short leave from the front.

J. H. PRIDGEON, a member of the staff at the Brakpan mine, has been appointed manager of the Daggafontein.

EDGAR RICKARD, managing director of *The Mining Magazine*, has returned to London on the conclusion of a two-months' visit to the United States.

H. LIONEL SARGENT has received a commission as Lieutenant in the Territorial Force Reserve.

E. W. SPENCER is returning to the Abosso mine, West Africa.

HEATH STEELE has taken offices at 60 Broadway, New York.

D. H. THACKER is acting general manager for the Randfontein Central Gold Mining Company.

W. F. A. THOMAE will act as the London representative of the firm of Wilkens & Devereux, of New York, during the absence on war work of Gordon S. Duncan.

W. E. THOMAS has returned from Nigeria.

SCOTT TURNER sailed from New York on April 8 for Peru.

E. A. WALLERS has been elected president of the Transvaal Chamber of Mines for the ensuing year.

D'ARCY WEATHERBE has returned from Canada, on the conclusion of his visit to the mines at Cobalt, owned by the Canadian Mining Corporation.

MORTON WEBBER, Lieutenant in the Royal Field Artillery, is convalescent from wounds received in the Balkans in December.

HENRY CARR WHITEHEAD has been promoted to the rank of Captain in the Royal Engineers, and has received the Military Cross. He was before the war on the staffs of the Randfontein and Kleinfontein.

R. S. WILE is about to go to Bolivia to erect electric tin-smelting furnaces.

FRANCIS WYATT, well known as the author of 'The Phosphates of America,' died at New York on February 27.

GEORGE S. YOUNG is returning to England from the Belgian Congo.

METAL MARKETS

COPPER.—With the restrictions put on dealings by the munitions authorities, the copper market has become uninteresting. Prices move in a narrow orbit, and while with the present heavy consumption there is little prospect of anything approaching a slump, active movement in an upward direction is discouraged. The end of the month of March indeed showed a downward tendency with a backwardation for forward delivery. It might have been greater had not the Department put such restrictions on the release of their holdings of the metal as to drive buyers into the open market. Dealers, on the other hand, are greatly handicapped by transport difficulties both by sea and land, and their enterprise is checked by the restrictions placed upon them, so that they prefer to limit their activities to a safe and obvious trade. The prospect for the immediate future, in spite of a continued decrease in visible supplies, does not lead to the expectation of higher levels, and in fact the obvious view would be to look for a heavy slump. This is no doubt within measurable distance, as there are no bears to lend support on a decline. But times are abnormal and the wastage of the metal is so extensive that the course of prices is not easy to predict.

During the month standard copper has risen from £106 to £115 for cash, but prices have become unstable, and movement is produced with a very small turnover. This sensitiveness appears likely to increase. Refined copper keeps very steady, and appears to be under quite different influences from those controlling the standard market. Consumers are keeping shy of forward purchases.

Average prices of cash standard copper: March 1916, £106. 19s. 11d.; February 1916, £102. 13s. 1d.; March 1915, £66. 5s. 5d.

Copper sulphate is quoted at £51. The following are quotations for copper and brass: Tough copper £128 per ton, best selected £129, rods £148, sheets £148, American electrolytic wire bars £136, solid drawn tubes 18½d. per lb., brazed tubes 18½d., wire 16½d., yellow metal 18d.; brass solid drawn tubes 17d. per lb., brazed tubes 19d., sheets 17d., wire 16½d.

TIN.—The market in this metal has shown considerable activity, and the price, which ruled at £183. 10s. for cash at the opening of March, was carried up at one time to £202. March closed under £200, however, and it looks as if for the time being the movement had come to an end. America's need is shown in the fact that £253 was realized there for spot tin, and shipments direct to New York from the East are encouraged by the heavy premiums ruling. Stocks in England have been reduced during the month, and are now at an inconveniently low level. Buyers in this country are on the whole not well covered, and it is imperative that the replenishment of stocks should be encouraged. In view of the high freights ruling, and the scarcity of tonnage available, this is a difficulty which is not easily overcome. Consumers are not well supplied, and shipments are under the estimates. English tin has become scarce, and sellers of standard have been delivering Straits in fulfilment of contracts. For this reason there is a tendency for the margin between standard and Straits to be reduced. Considerable sales have been made to Italy and France. Russia is expected to become a large buyer shortly for Archangel. There is now a backwardation of from £4 to £6 on the metal.

Average prices of cash standard tin: March 1916, £193. 13s. 11d.; February 1916, £181. 3s. 4d.; March 1915, £180. 10s. 10d.

LEAD.—Fluctuations in this metal have become violent, and the market is so sensitive that the quotation is affected by offerings of small parcels. Supplies are fairly plentiful, but the demand on the open market is quite negligible, the arrivals being either on account of the Munitions Authority or against old-time contracts. Silver-lead is rather plentiful, but the labour necessary to refine it is scarce, and accordingly accumulations at the refineries are held up, and interfere somewhat with rapid output. The price which was quoted at £33 early in March rose to £36. 10s., but fell away again later, closing at £35. The American situation is unsettled, the latest quotation being nominally 6·75 cents, but deals have been put through at much higher figures. The Mexican troubles are at the foundation of the scarcity there, and little is heard of American offerings on this side. The domestic output is all needed for home demand, and no surplus is available for export. Spanish lead is becoming even scarcer than in the recent past, and is likely to remain so. It is difficult to see any lasting fall in prices; on the contrary very little ordinary trade demand would suffice to create a feeling of acute scarcity.

Average prices of soft foreign lead: March 1916, £34. 7s. 8d.; February 1916, £31. 18s. 9d.; March 1915, £21. 17s. 8d.

SPELTER.—Quotations are wide, and owing to difficulties of freighting contracts are getting more and more into arrears. Buyers here naturally are only buying from hand to mouth, but in doing so they are falling into the hands of the American sellers. The official prices are found to be a good deal under the level of actual business. Production is still increasing there, but consumption is likewise expanding. The controlling feature however is the inadequate transport facilities. The markings on the Metal Exchange varied from £110 to £95 early in March to £92 to £82, subsequently closing at £96 to £84.

Average prices of good ordinary brands: March 1916, £90. 1s. 9d.; February 1916, £93. 10s. 11d.; March 1915, £44. 2s. 7d.

ANTIMONY.—The market continues to be nominal. The last quotation some months ago was £120 per ton. Ore is quoted at 10s. per unit. Chinese antimony tends to decrease in America, the price being 42 to 43 cents per lb.

QUICKSILVER.—The price of Spanish quicksilver remains at £16 15s. per flask of 75 lb. In America the stringency has been relaxed, and the price has fallen to $175 per flask.

BISMUTH.—The price has been raised to 11s. per lb.

CADMIUM.—7s. 6d. per lb.

PLATINUM.—As the Government now has control of supplies of this metal, none can be bought in the market. Johnson, Matthey & Co., acting as purchasing agents for the Government, offer 202s. per ounce. In America the price remains at about $90 per oz., and supplies are very short.

NICKEL.—The quotation for nickel remains at about £220 per ton. In the United States the price is 45 to 50 cents per lb., and electrolytic 5 cents higher. The nickel position in Canada is obscure, and such announcements as are made with regard to the control of Sudbury supplies and their refining, and the ultimate destination of the nickel produced, do not disclose the inside political history of the agitation.

ALUMINIUM.—For some time this metal has been under Government control and purchases can only be made by consent. The price is nominal, but £160 may be mentioned as a fair average. In America sales have been made at 59 to 61 cents per lb., and the demand is strong.

IRON.—The Government authorities have taken control over the prices of pig iron, and an official list of prices of all varieties has been issued, intended to hold good until June 30 and thereafter until further notice. This action follows the interdiction of speculative dealings recorded last month. The highest price recorded for Cleveland No 3 had been 93s. per ton, and the repression of speculation depressed the price to 86s.; but the price was again forced up and 95s. was recorded just before the official prices were circulated. The official price for Mixed Numbers 1, 2, 3 is 82s. 6d. Cumberland hematite iron Mixed Numbers is fixed at 127s. 6d.; hematite iron East Coast 122s. 6d.; Staffordshire cold blast 177s. 6d. Spanish iron ore is quoted at 43s. per ton delivered at Middlesbrough. Swedish ores are nominally quoted at 40s. for 0·6% maximum phosphorus.

MANGANESE.—The quotation for Indian ores is 2s. 8d. per unit on the basis of 50%, and for Brazilian on the same basis 4s. per unit, both delivered in England. Ferro-manganese continues to be quoted at £25 per ton. The ferro position in America continues serious, and steel makers who are not protected by contracts or by possession of their own supplies are having to pay fabulously high prices, as much as £80 being recorded. Supplies from England under new contracts are promised for delivery not before 1917, at prices around £35. Metallic manganese 90 to 95% free from carbon is quoted at 2s. 8d. per lb.

MOLYBDENUM.—The official price for molybdenite remains at 105s. per unit averaging 90% MoS_2. Last month we mentioned that the ***Engineering and Mining Journal*** quoted molybdenite at 6s. per unit. It has been suggested to us that the Journal's word 'unit' should have been 'pound.' Ferro molybdenum, 65 to 85% molybdenum 18s. per lb.

TUNGSTEN.—The official quotation for wolfram and scheelite remains at 55s. per unit of WO_3. In the United States $85 per unit is being paid for spot supplies, and $70 for forward delivery. Ferro-tungsten 80 to 90%, low carbon 5s. 8d. per lb. Tungsten metal powder 96 to 98%, 5s. 10d. per lb. High-speed steel 14%, tungsten 2s. 10d. per lb., 18% tungsten 3s. 10d. per lb.; scrap returned to makers paid for at the rate of 5d. or 6d. per lb.

CHROMIUM.—The following quotations for chrome ores are given by Chalas & Sons; New Caledonia ore 53 to 55%, basis price for 50% Cr_2O_3, 36s. per ton f.o.b., scale 2s. Baluchistan ore 53 to 55%, basis price for 50% Cr_2O_3, 36s. per ton f.o.b. Rhodesia ore 48 to 52%, basis price for 48% Cr_2O_3, £6. 12s. 6d., c.i.f. London, scale 2s. Rhodesia ore 47%, £6. 5s. per ton flat. Ferro-chrome, 8 to 10% carbon, basis 60%, £32. 10s. per ton, basis of 10s. per unit; 6 to 8% carbon £33. 15s.; 2% carbon £86, scale 32s. per unit.

TITANIUM.—Ferro-titanium 15 to 18% Ti, and 5 to 8% carbon is quoted at 6½d. per lb.; 23 to 25% Ti, free from carbon, 1s. 9d. per lb.

VANADIUM.—Ferro-vanadium is quoted at 14s. 6d. per lb. of vanadium contained.

FERRO-SILICON.—Basis 75% Si, £48 per ton; grade 45 to 50% Si, basis 45%, £28. 10s. per ton, scale 7s. 6d. per unit.

COBALT.—96 to 98%, 8s. per lb.

SILVER.—The price of silver sharply advanced toward the end of March, and 28½d. per standard ounce was registered. The political crisis in China appears to be partly accountable for the rise, and the revival of inquiry from India also acted as a stimulus. Coinage requirements for England and France have of recent months caused a shortage of stocks, so that the unexpected demand soon had its effect on the market.

PRICES OF CHEMICALS. April 7.

		£	s.	d.
Acetic Acid, 40%	per cwt.	3	2	6
,, 60%	,,	5	0	0
,, Glacial	,,	10	0	0
Alum	per ton	11	0	0
Alumina, Sulphate of	,,	14	0	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	30	0	0
,, Chloride of, grey	per cwt.	1	13	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	55	0	0
,, Phosphate of	,,	90	0	0
,, Sulphate of	,,	17	0	0
Arsenic, White	,,	30	0	0
Barium Chloride	,,	28	0	0
,, Carbonate	,,	5	0	0
,, Sulphate	,,	5	10	0
Bisulphide of Carbon	,,	30	0	0
Bleaching Powder, 35% Cl.	,,	17	10	0
Borax	,,	28	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	2	0	0
Copper, Sulphate of	,,	51	0	0
Creosote	per gal.		0	4
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		13	9
Iron, Sulphate of	per ton	3	5	0
Lead, Acetate of, white	,,	105	0	0
,, Chemical Sheet Metal	,,	42	0	0
,, Nitrate of	,,	90	0	0
,, Oxide of, Litharge	,,	44	0	0
,, White	,,	45	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	12	10	0
Oxalic Acid	per lb.		1	8
Phosphoric Acid	,,			11
Potassium Bichromate	,,		1	11
,, Carbonate	per ton	170	0	0
,, Chlorate	per lb.		2	5
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb		8	9
,, Prussiate, Yellow (Ferricyanide)	,,		4	3
,, Sulphate, 90%	per ton	55	0	0
Sodium Metal	per lb.		1	4
,, Acetate	per ton	68	0	0
,, Bicarbonate	,,	6	10	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	10	0
,, Hydrate, 76%	,,	17	10	0
,, Hyposulphite	,,	17	0	0
,, Nitrate, 95%	,,	17	10	0
,, Phosphate	,,	27	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	12	6
,, Sulphide	,,	27	0	0
Sulphur, Roll	,,	13	0	0
,, Flowers	,,	13	10	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tartaric Acid	per lb.		3	8
Tin Chloride (Tin Crystals)	,,		1	3
Zinc Chloride, solution 100°T.	per ton	32	10	0
Zinc Sulphate	,,	31	0	0

STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
July 1915	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122
November	753,605	27,408	781,013	3,317,534
December	755,101	26,010	781,111	3,317,949
Year 1915	8 772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063
March	768,714	27,975	796,689	3,384,121

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9,468	970	219,864
March	203,575	9,588	917	214,080

COST AND PROFIT ON THE RAND.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846
May	2,416,966	25 8	17 0	8 6	1,031,220
June	2,346,493	26 1	17 2	8 8	1,017,908
July	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229
December	2,410,841	26 5	17 10	8 2	985,361
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
January 1916	2,449,518	26 1	17 10	7 10	962,120

PRODUCTION OF GOLD IN RHODESIA AND WEST AFRICA.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	313,769	144,034	137,739
March	299,686	—	153,770	—
April	315,541	—	149,978	—
May	318,898	—	142,123	—
June	322,473	—	135,289	—
July	336,565	—	140,290	—
August	344,493	—	139,364	—
September	321,085	—	135,744	—
October	339,967	—	141,771	—
November	313,160	—	122,138	—
December	331,376	—	158,323	—
Total	3,823,166	632,355	1,706,473	278,318

PRODUCTION OF GOLD IN WESTERN AUSTRALIA.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
July 1915	555	98,859	98,757	419,495
August	1,079	99,941	104,258	442,900
September	2,019	100,833	93,764	398,282
October	2,346	100,238	102 609	435,853
November	797	99,206	103,670	440,360
December	2,883	96,997	101,309	430,333
Year 1915	17,277	1,192,790	1,210,067	5,140,189
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,138	67,970	288,717
March	5,600	88,393	93,993	399,255

PRODUCTION OF GOLD IN VICTORIA AND QUEENSLAND.

	Victoria.		Queensland.	
	1915	1916	1915	1916
	£	£	£	£
January	69,900	89,900	43,770	66,700
February	122,300	76,500	85,850	79,050
March	142,800	—	98,550	—
April	109,300	—	97,320	—
May	102,900	—	130,470	—
June	134,200	—	90,500	—
July	154,800	—	88,830	—
August	80,300	—	93,050	—
September	138,900	—	79,470	—
October	111,700	—	91,800	—
November	115,300	—	77,780	—
December	115,400	—	81,170	—
Total	1,397,800	166,400	1,078,560	145,750

PRODUCTION OF GOLD IN INDIA.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	186,475
April	191,215	189,197	196,747	—
May	190,607	193,031	199,786	—
June	189,322	192,224	197,447	—
July	193,859	195,137	197,056	—
August	193,998	196,560	197,984	—
September	191,642	195,843	195,952	—
October	194,314	198,191	195,531	—
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	561,889

DAILY LONDON METAL PRICES
in £ per long ton.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard
Mar.	£ s. d.	£	£ s. d	£	£ s. d.
1	101 5 0	136	32 17 6	110	188 2 6
7	100 17 6	136	31 17 6	110	187 2 6
8	95 17 6	136	32 0 0	98	187 2 6
9	97 15 0	136	32 17 6	95	188 2 6
10	102 15 0	136	33 10 0	93	189 12 6
13	102 17 6	136	34 5 0	85	192 7 6
14	105 2 6	136	35 5 0	85	192 15 0
15	105 2 6	136	35 0 0	90	194 12 6
16	106 2 6	136	35 2 6	92	195 5 0
17	107 7 6	136	35 10 0	92	195 12 6
20	108 17 6	136	36 7 6	92	196 7 6
21	112 2 6	136	36 0 0	92	195 17 6
22	118 5 0	135	36 0 0	94	196 12 6
23	113 5 0	136	35 2 6	94	197 5 0
24	113 5 0	136	35 5 0	93	199 15 0
27	113 15 0	136	35 5 0	96	201 5 0
28	113 5 0	136	34 15 0	95	202 5 0
29	112 12 6	136	35 0 0	95	200 5 0
30	113 0 0	136	34 17 6	95	200 0 0
31	115 15 0	136	34 17 6	96	199 5 0
April					
3	115 2 6	136	34 12 6	93	197 15 0
4	115 15 0	136	34 0 0	91	197 12 6
5	117 5 0	136	32 0 0	92	199 5 0
6	116 15 0	135	32 17 6	93	201 5 0
7	117 5 0	134	33 10 0	94	202 2 6

IMPORTS OF ORES AND METALS INTO UNITED KINGDOM.
Long tons.

	Year 1915	Feb. 1916	Mar. 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	3,928	2,085	10,124
,, Matte and Precipitate	38,372	1,793	1,600	8,286
,, Metal (unwrought and part wrought)	180,368	9,906	9,441	32,026
Copper and Iron Pyrite	903,401	79,081	73,977	254,948
Tin Concentrate	44,748	1,899	3,890	7,863
,, Metal	38,896	938	2,434	6,234
Manganese Ore	377,324	24,511	30,476	87,098
Lead, Pig and Sheet	256,476	19,490	16,213	47,870
Zinc (spelter)	74,520	3,771	2,936	9,579
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	376,600	—	759,290

STOCKS OF COPPER.
Reported by Henry R. Merton & Co. Ld. Long tons.

	Jan. 31, 1916	Feb. 29, 1916	Mar. 31, 1916
	Tons	Tons	Tons
Standard Copper in England	7,178	4,127	2,093
Fine Copper in England	1,573	734	35
,, ,, Havre	1,247	4,950	3,400
,, ,, Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*
,, ,, Afloat from Chile	3,525	2,300	1,750
,, ,, ,, from Australia	4,000	4,500	4,800
Total Visible Supply	22,646	21,734	17,201
In other European Ports Estimated	500*	500*	—

* As on July 31, 1914, but presumably present stock nil.

EXPORTS OF COPPER FROM UNITED STATES
Reported by United States Customs.

1915	Long tons	1915	Long tons	1916	Long tons
January	28,197	July	16,812	January	21,863
February	12,066	August	16,289	February	20,548
March	29,725	September	14,327	March	—
April	20,481	October	26,153	April	—
May	25,785	November	19,396	May	—
June	15,751	December	32,936	June	—
		Total 1915	257,915	Total 1916	42,411

STOCKS OF TIN.
Reported by A. Strauss & Co. Long tons.

	Jan. 31, 1916	Feb. 29, 1916	Mar. 31, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	836	747	619
Ditto, Landing and in Transit	329	227	.025
Other Standard, Spot and Landing	1,940	1,607	886
Straits, Afloat	1,765	4,330	4,620
Australian, Afloat	365	315	325
Banca, on Warrants	—	—	—
Ditto, Afloat	756	1,540	4,340
Billiton, Spot	—	17	17
Ditto, Afloat	335	417	333
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,105*	1,850*	1,105*
Afloat for United States	7,637	5,808	4,405
Stock in America	2,401	1,308	2,746
Total Stock	17,468	18,166	20,421

* Including 705 tons on board enemy's ships either captured or lying in neutral ports.

SHIPMENTS AND IMPORTS OF TIN.
Reported by A. Strauss & Co. Long tons.

	Year 1915	Feb. 1916	Mar. 1916	1915 to date
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	3,015	2,175	6,730
Straits to America	31,565	2,090	2,500	8,795
Straits to Continent	11,024	1,145	495	1,990
Australia to U.K.	2,481	316	245	885
U.K., Holland, and Continent to America	14,967	323	1,060	2,735
Imports of China Tin into U.K. and America	3,012	85	35	185
Imports of Bolivian Tin into Europe	22,591	640	1,583	3,089

NIGERIAN TIN PRODUCTION.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	528
March	247	510	502	418	—
April	141	430	482	444	—
May	144	360	480	357	—
June	121	321	460	373	—
July	140	357	432	455	—
August	201	406	228	438	—
September	196	422	289	442	—
October	256	480	272	511	—
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	1,059

PRODUCTION OF TIN IN FEDERATED MALAY STATES.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3.313
March	3,196	3,562	3,839	3,653	3,696
April	3,904	4,066	4,087	3,619	—
May	4,277	4,319	4,135	3,823	—
June	3,472	3,993	4,303	4,048	—
July	4,234	4,245	4,582	3,544	—
August	4,454	4,620	3,591	4,046	—
September	4,115	4,379	3,623	3,932	—
October	3,905	4,409	3,908	3,797	—
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46,767	11,325

SALE OF TIN CONCENTRATE AT REDRUTH TICKETINGS.

	Long tons	Value	Average
Year 1911	6151½	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
July 5, 1915	202	£18,721	£92 13 5
July 19	204½	£18,102	£88 10 5
August 3	177	£15,069	£85 2 9
August 16	171	£14,098	£82 9 0
August 30	156	£12,935	£82 18 5
September 13	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3
October 11	166	£13,620	£82 1 0
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0
December 20	181½	£16,941	£93 6 10
Total, 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18,122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179½	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5
March 13	182	£19,921	£109 9 2
March 27	190½	£21,437	£112 10 6

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:

	Apr. 1 1915	Mar. 1 1916	Apr. 1 1916
RAND:			
Bantjes	11	12	18
Brakpan	51	75	76
Central Mining (£12)	122	120	130
Cinderella	4	6	7
City & Suburban (£4)	49	35	35
City Deep	58	74	76
Consolidated Gold Fields	29	27	28
Consolidated Langlaagte	34	31	32
Consolidated Main Reef	18	20	19
Consolidated Mines Selection (10s)	9	16	17
Crown Mines (10s.)	85	56	56
D. Roodepoort Deep	15	15	15
East Rand Proprietary	34	17	17
Ferreira Deep	45	34	37
Geduld	24	35	45
Geldenhuis Deep	22	21	22
Gov't Gold Mining Areas	61	31	34
Heriot	22	50	51
Jupiter	5	7	7
Kleinfontein	24	28	31
Knight Central	6	17	16
Knight's Deep	21	22	22
Langlaagte Estate	18	18	19
Luipaard's Vlei	7	9	9
Main Reef West	8	9	9
Meyer & Charlton	102	106	106
Modderfontein B	93	110	119
Modder Deep	72	111	130
Modderfontein, New (£4)	269	301	325
Nourse	22	15	17
Rand Mines (5s.)	94	75	74
Randfontein Central	13	10	13
Robinson (£5)	36	20	20
Robinson Deep	26	20	21
Rose Deep	36	26	27
Simmer & Jack	9	7	7
Simmer Deep	1	3	2
Springs	20	48	55
Van Ryn	59	40	45
Van Ryn Deep	46	59	62
Village Deep	36	34	27
Village Main Reef	31	21	21
Witwatersrand (Knight's)	59	56	55
Witwatersrand Deep	39	24	26
Wolhuter	13	10	11
RHODESIA:			
Cam & Motor	15	11	11
Chartered	12	10	11
Eileen Alannah	9	9	9
Eldorado	15	9	9
Enterprise	5	4	4
Falcon	11	9	10
Giant	[illegible]	6	7
Globe & Phœnix (5s.)	30	20	25
Lonely Reef	24	23	25
Shamva	37	34	34
Wanderer (5s.)	3	1	1
Willoughby's (10s.)	6	5	5
OTHERS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	240	220	220
Glynn's Lydenburg	10	10	10
Jagersfontein	60	65	67
Premier Diamond Defer'd (2s. 6d.)	102	92	100
Sheba (5s.)	4	2	2
Transvaal Gold Mining Estates	37	23	27
WEST AFRICA:			
Abbontiakoon (10s.)	9	8	7
Abosso	9	10	9
Ashanti (4s.)	15	19	19
Broomassie (10s.)	2	½	½
Prestea Block A	12	8	10
Taquah	15	19	19
WEST AUSTRALIA:			
Associated Gold Mines	5	5	5
Associated Northern Blocks	5	4	3
Bullfinch	6	5	4
Golden Horse-Shoe (£5)	50	40	39
Great Boulder Proprietary (2s.)	16	15	13
Great Boulder Perseverance	2	1	1
Great Fingall	7	2	2
Ivanhoe (£5)	59	44	45
Kalgurli	37	14	12
Sons of Gwalia	19	15	13
Yuanmi	2	2	2

GOLD, SILVER, *cont.*	Apr. 1 1915	Mar. 1 1916	Apr. 1 1916
OTHERS IN AUSTRALASIA:			
Blackwater	15	15	15
Consolidated Gold Fields of N.Z.	11	11	11
Mount Boppy	11	15	15
Mount Morgan	47	44	42
Progress	6	5	5
Talisman	27	15	12
Waihi	44	35	34
Waihi Grand Junction	25	19	19
AMERICA:			
Alaska Treadwell (£5)	145	130	130
Buena Tierra	13	14	14
Butters Salvador	10	12	—
Camp Bird	6	7	7
Canadian Mining	9	10	9
Casey Cobalt	8	4	3
El Oro	8	8	8
Esperanza	9	10	9
Frontino & Bolivia	8	9	10
Kirkland Lake Proprietary	31	20	20
Mexico Mines of El Oro	75	74	75
Oroville Dredging	12	13	14
St. John del Rey	15	15	15
Santa Gertrudis	8	10	10
Tomboy	24	21	21
Tough-Oakes	14	12	11
RUSSIA:			
Lena Goldfields	36	35	34
Orsk Priority	—	15	17
INDIA:			
Champion Reef (2s. 6d.)	11	[illegible]	8
Mysore (10s.)	86	82	77
Nundydroog (10s.)	26	27	27
Ooregum (10s.)	27	24	23

COPPER:

	Apr. 1 1915	Mar. 1 1916	Apr. 1 1916
Anaconda (£10)	119	360*	362*
Arizona Copper (5s.)	32	35	36
Cape Copper (£2)	55	62	62
Chillagoe (10s.)	½	½	½
Cordoba (5s.)	3	4	4
Great Cobar (£5)	1	4	3
Hampden Cloncurry	25	41	41
Kyshtim	53	39	44
Messina (5s.)	10	11	11
Mount Elliott (£5)	70	60	76
Mount Lyell	26	28	29
Rio Tinto (£5)	1205	1205	1240
Sissert	24	21	21
South American Copper (2s.)	13	15	15
Spassky	41	40	40
Tanalyk	54	35	44
Tanganyika	29	39	39

LEAD-ZINC:

	Apr. 1 1915	Mar. 1 1916	Apr. 1 1916
BROKEN HILL:			
Amalgamated Zinc	24	29	29
British Broken Hill	27	25	29
Broken Hill Proprietary (8s.)	41	59	65
Broken Hill Block 10 (£10)	26	15	24
Broken Hill North	46	49	48
Broken Hill South	145	154	157
Sulphide Corporation (15s.)	19	22	23
Zinc Corporation (10s.)	15	14	15
ASIA:			
Burma Corporation	31	36	34
Irtysh Corporation	—	35	41
Russian Mining	22	13	16
Russo-Asiatic	106	95	104

TIN:

	Apr. 1 1915	Mar. 1 1916	Apr. 1 1916
NIGERIA:			
Bisichi	8	6	9
Ex-Lands Nigeria (2s.)	1	1½	1½
Mongu	—	9	9
Naraguta	17	17	18
N. Nigeria Bauchi (10s.)	1	2	3
Rayfield	5	4	7
Ropp (4s.)	17	14	17
OTHER COUNTRIES:			
Aramayo Francke	27	26	25
Briseis	6	5	5
Cornwall Tailings	15	5	5
Dolcoath	8	7	9
East Pool	10	17	32
Gopeng	29	31	31
Pahang Consolidated (5s.)	7	9	11
Renong Dredging	21	29	29
South Crofty (5s.)	6	8	12
Tekka	60	54	57
Tronoh	32	34	39

* Denomination of shares recently changed from £5 to £10.

THE MINING DIGEST

A PRECIS OF MINING TECHNOLOGY, DEVELOPMENT, AND LITERATURE

[*In this department will be found listed the more important articles and miscellaneous publications appearing each month which deal with metal mining and non-ferrous mineralogy, the more significant publications being abstracted or reviewed. Copies of the originals can be obtained through the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.*]

FLOTATION TESTS AT ANACONDA.

We have on several occasions referred to the adoption by the Anaconda Copper Mining company of the principle of flotation, and of the remodelling of the concentrators whereby the whole of the sand tailing and of the slime is now sent to Minerals Separation plant. Before this particular type of flotation plant was adopted, extensive tests were made of other processes, of which the Callow received chief attention. The March *Bulletin* of the American Institute of Mining Engineers contains a lengthy paper by Frederick Laist and Albert E. Wiggin, respectively metallurgical manager and superintendent of concentration to the company, describing tests and giving details of the remodelled plant. For the convenience of our readers we divide this paper into two parts, according to the two sections of the paper. In this article we refer to the tests; in an article following we describe the completed plant.

The tests at Anaconda are of special interest because the performances of the Minerals Separation and the Callow plant were closely compared. In other copper districts the Callow has been adopted, notably in Arizona. The preference for one or the other process does not necessarily depend solely on the technological problem; the patent position also becomes a factor when the business side of the question is considered. Separate series of tests were made, one dealing with the tailing from the sand-tables, and the other with the slime. The latter problem involved also the investigation as to whether the slime tailing from the round frames should be treated or whether the round frames should be eliminated and the slime treated direct. Experiments were also made in connection with the best oil to use, the temperature of operation, and other points.

The slime assays 2·3 to 2·6% copper, 90 to 95% passes 200-mesh, and it contains 35% colloidal solids. The Minerals Separation plant used in the test had 16 agitator compartments each 2 ft. square, and 14 spitzkasten. The agitators were 18 in. diameter, and made 265 revolutions per minute, the peripheral speed being 1245 ft. per minute. The horse-power consumed was 45 to 55 when operating under full load. The results of the tests were: (1) The capacity of the machine giving the best economic results was 80 to 90 tons per day. (2) The best proportion of solids to water for the slime pulp was 12% solids. (3) The best temperature was 70° F. (4) The oil giving the best results was a mixture of acid kerosene sludge, wood creosote, and stove oil, with some sulphuric acid added (the sludge is a by-product from the distillation and purification of kerosene, and stove oil is largely kerosene). (5) The real value of stove oil was open to question and its principal function was to make a more compact froth. (6) No advantage was gained by retaining the use of the round tables. (7) The economic degree of concentration was obtained when the tailing contained 0·3% copper and the concentrate 40% gangue; probably a cleaner concentrate might eventually be obtained without any sacrifice in the recovery. (8) The peripheral speed should not exceed 1300 ft. per minute. (9) The kerosene sludge contained acid, but it was necessary to add more sulphuric acid.

The treatment of the sand tailing involves re-grinding to pass 60-mesh; about 37% then passed 240-mesh. The assay of this tailing was 0·6 copper. The results of tests with Minerals Separation plant were: (1) The economical capacity of the machine was 175 to 200 tons per day. (2) The best oil was acid kerosene sludge, with additional acid; a mixture of creosote, turpentine, and pine oil without acid gave good results also, but its use involved more delicate adjustment and more careful attendance. (3) The grinding mills made ideal agitators, and it was found advantageous to add the oil ahead of them. (4) The best pulp density was 25 to 30% solids. (5) The economic degree of concentration was when the tailing assayed 0·1% copper, and the concentrate 30% gangue. (6) The pulp should be heated to 70° F., though this was not necessary in the summer months. (7) Additional acid was not so necessary as in the case of the slime. (8) It was found inadvisable to mix the re-ground sand tailing with the slime and treat the two together in the flotation machine.

The Callow test-plant consisted of 5 cells, each 2 by 8 ft., a Pachuca agitator, and a blower. Mechanical agitators were added by the Anaconda engineers as an alternative for the Pachuca. The motor driving the blower indicated 47·4 h.p., 35·4 h.p., and 25·8 h.p. for pressures of 6, 5, and 4 lb. respectively. When this plant was treating slime, the following results were obtained: (1) Mechanical agitation was preferable to Pachuca agitation. (2) The capacity of each cell was 15 to 20 tons per day. (3) The Callow machine produced a clean concentrate but not so clean a tailing as the Minerals Separation plant. (4) The Callow machine proved more sensitive and required closer attention. (5) The cost of repairs would probably be less with a Callow, but in any case the cost was small in both machines. (6) The power required with the two machines was about the same.

When the Callow plant was tried with the re-ground sand tailing, the following results were obtained: (1) The capacity of the Callow cell was 75 tons per day. (2) No other agitation was required if the oil was added ahead of the grinding mills, and the elimination of the agitator brought the cost of power below that of the Minerals Separation plant. (3) The use of acid was proved to be of considerable advantage. (4) The Callow machine was more sensitive and required more attention than the Minerals Separation plant.

The result obtained by these series of tests was that the Minerals Separation plant was found to be best adapted for Anaconda ore, the deciding factors being the better recovery and the less attention required. From exigencies of space we have not given any details of the experiments. Those interested in the performance of the Minerals Separation process under varying conditions will closely study the original paper. In the next paragraph we give details of the reconstructed concentrating plant.

THE REMODELLED CONCENTRATION PLANT AT ANACONDA.

On a previous page we have given an outline of the competitive tests between Callow and Minerals Separation plants, extracted from a paper by Frederick Laist and Albert E. Wiggin published in the March *Bulletin* of the American Institute of Mining Engineers. The adoption of the Minerals Separation process made it desirable to remodel the concentration plant. Messrs. Laist and Wiggin's paper describes the remodelled plant, and we quote the description herewith.

The remodelled concentrator consists of eight sections, each of 2000 tons per day capacity, giving a grand total of 15,000 tons per day, allowing for shut-downs, repairs, etc. All sections are alike with the exception of Section 1. In this section there are slight variations mentioned later. In each section the ore is fed from the bins to a 2-in. round-hole shaking screen, the oversize going to a 12 by 24-in. Blake crusher. The product from this crusher is delivered to a 2-in. round-hole trommel, the oversize of which is sent to two 8 by 20-in. Blake crushers. The product from these crushers, together with the undersize from the 2-in. screens, is elevated and passed through 1-in. round-hole trommels. The oversize from this is treated in coarse Harz jigs, making a middling and a concentrate; the undersize is passed through ⅜-in. trommels, the oversize being treated in fine Harz jigs making a concentrate and a middling. All sections are alike up to this point. In Section 1, the undersize from the ⅜-in. trommel is screened on 1½ by 12-mm. trommels, the undersize going to the Anaconda classifiers and the oversize to the Hancock jigs. The treatment of the products from this point is the same in all sections, except that Section 1 uses tube-mills in place of Hardinge mills for grinding. The undersize from the ⅜-in. trommel is screened through 4-mm. trommels, the oversize from these going to the double compound Evans jigs and the undersize going to 1½ by 12-mm. trommels. The undersize from these trommels goes to the Anaconda classifiers, the oversize to double compound Evans jigs. The two sets of Evans jigs make a concentrate which goes to the dewatering bins and a middling which is ground for further treatment.

The concentrate from the coarse Harz jigs is dewatered and conveyed to bins. The middling is screened on a dewatering screen, the undersize together with the hutch product from the coarse Harz jigs going to the Evans jigs. The oversize is passed through rolls, 54 by 24 in., and thence back into the system ahead of the 1-in. round-hole trommels. The concentrate from the fine Harz jigs is sent to the bins. The middling is screened through a dewatering screen, the oversize going to 54 by 24-in. rolls and then back into the system ahead of the 1-in. round-hole trommels. The undersize of the dewatering screen together with the hutch discharge of the fine Harz jigs goes to the Evans jigs.

The concentrate from the Evans jigs is dewatered in bins to about 7% moisture, and sent to the smelter. The jig concentrate assays about 15% insoluble and 8% copper. The middling, together with the hutch product, is dewatered in tanks and screened through 1½ by 12-mm. trommels, the undersize from which goes to the Anaconda classifiers, the oversize through 54 by 24-in. rolls, and back to the 1½ by 12-mm. trommels.

The spigot from the Anaconda classifier is treated on 18 Wilfley tables, fitted with Butchart riffling, making a concentrate and a middling. These tables make a concentrate assaying 25% insoluble and a middling assaying 0·9% Cu. The concentrate is sent to the dewatering bins, together with the fine jig concentrate, and the middling is sent to the 10 by 4-ft. Hardinge mills. The overflow from the Anaconda classifiers is sent to the slime thickener division, consisting of 28 by 3-ft. Dorr tanks. The spigot product from these tanks is divided; about one-half is returned to the section and the remainder is sent to the slime plant. The product from the Hardinge mills is treated in six simplex Dorr classifiers, one classifier to each mill, the overflow going to the flotation division and the classifier sand being returned to the mill.

At the time it was first decided to remodel the concentrator, it was not definitely known whether pebbles or steel balls would be used for grinding. To provide for this uncertainty a compromise was effected. The mills were made 10 by 4 ft. and built sufficiently strong for steel balls in case balls were used. Each mill was equipped with a 225-hp. motor directly connected through a flexible coupling. The mill filled with pebbles takes from 95 to 115 hp. to operate. In case steel balls were used it was planned to put in a false wood lining back of the steel lining in the cylindrical part of the mill to reduce the effective diameter of the mill. This latter plan was finally adopted, and the Hardinge mills will be equipped with the false wood lining, 15 in. thick, in the cylindrical part of the mill, and a cascade steel lining. With this form of lining, the mill is virtually 7½ by 6 ft. and requires about 225 hp. when loaded with steel balls.

The flotation division consists of four Minerals Separation machines, each having 15 agitators 3 ft. square, and 14 spitzkasten or floating compartments. The agitators are of gun metal and are driven by bevel gears from a line shaft, the direction of rotation of the agitators alternating. The machines are made of California red wood; the agitator boxes are further lined with hard maple extending about 18 in. from the bottom of the box. Each machine has an individual drive, power being supplied to the line shaft by a 150-hp. motor running at 385 r.p.m. The speed of the agitators is 225 r.p.m. and as the impellers are 18 in. in diameter the peripheral speed is about 1060 ft. per minute. Each machine makes three products: a concentrate, which goes to the dewatering division, a middling which is returned to the head of the machine, and a tailing which goes to waste. The concentrate is taken from the first three to five spitzkasten and the middling from the last nine to eleven. A portion of the pulp is overflowed from the last three spitzkasten together with the froth. About 6 to 8 lb. of 50°B. H_2SO_4 per ton of flotation feed is used together with

2 to 3 lb. of acid kerosene sludge and ½ to 1 lb. of crude wood creosote. A portion of the wood creosote is added ahead of the Hardinge mill (about 0·03 to 0·05 lb. per ton of feed) and the remainder is added in the sixth agitating compartment. The sulphuric acid and sludge are added at the head of the machine. The pulp is heated to from 60° to 70°F., by passing live steam into it at the head of the machine. Three machines are used for treating sand and the fourth for treating current slime from the upper portion of the mill. Each machine has a capacity of about 400 tons per day on sand and 175 tons on slime.

The method of adding the oil and acid deserves mention. The mechanism consists of a revolving disc to which are attached, around the circumference, a number of cups. This disc is set vertically so that its lower edge dips into a pan of acid or oil. As the cups come round they are filled, and later discharge their contents into a suitable launder leading to the flotation machine. The disc is driven by the friction of a wheel against another disc attached to the main drive. The wheel is run at constant speed, and by varying the point of contact between wheel and disc any speed desired can be given to the main disc and thus the amount of oil or acid added can be regulated. In addition to the speed regulation, the amount of oil or acid fed may be varied by adding or removing cups or by changing the size of the cups.

As mentioned, part of the slime is treated in the main plant, but as the accommodation in the building was not sufficient for the whole of the flotation plant for the slime, the additional plant required had to be placed in a building specially erected. This plant will treat 2000 tons per day of current slime and 1000 tons of accumulated slime. The latter has been stored for many years and has been partly oxidized so that the recovery will not be so high. Experiments were undertaken for the purpose of sulphidizing the oxidized slime by means of sulphide of soda, but the results were not promising.

THE HISTORY OF ROSSLAND, BRITISH COLUMBIA.

Rossland loomed large in London during the years from 1897 to 1900, during the famous Whitaker Wright boom, when a London company was floated by the British America Corporation to acquire the shares of the Le Roi gold-copper mine, and the Le Roi No. 2 was formed to purchase adjoining claims. The discrediting of Whitaker Wright's methods led to the equally famous collapse of 1901. After those days, the two companies continued working under new controls. No. 2 is still in the hands of the English company, but the Le Roi was purchased in 1911 by the Consolidated Mining & Smelting Company of Canada, and is worked conjointly with the War Eagle and Centre Star mines. The Memoir of the Geological Survey of Canada just published, on the 'Geology and Ore Deposits of Rossland, British Columbia,' by Charles W. Drysdale, contains, in addition to excellent geological descriptions of the region, a history of the development of the camp and mining district. A record of the early doings has never been published in this country as far as we remember, and in any case most of our readers will have forgotten the details. We therefore reproduce here the account given by Mr. Drysdale.

Although lead was discovered on Kootenay lake at the Bluebell mine, in the early twenties of the last century and was used as a source of lead for bullets by the Hudson's Bay Company, mining in West Kootenay district is of recent growth. In the early sixties, a few hardy prospectors came northward, attracted by the rich placers of the Cariboo, and tested and worked some of the local streams for gold. In 1865 the Dewdney trail was completed, from Hope on the Fraser river to the placers of Wild Horse and other East Kootenay creeks, passing close by the site of Rossland, down Trail creek. In the eighties, some claims were staked in the Boundary district; in 1883, at Ainsworth on Kootenay lake; and in 1886, rich ore was discovered on Toad mountain, near Nelson. In 1887, the news of the discovery had attracted prospectors, and a trading post was established at Nelson. These discoveries started prospectors along the Dewdney trail, on the look-out for lode ores. The first claim located was the Lily May, on the trail itself. It was discovered in 1887, and re-located in 1889 by Oliver Bordeau and Newlin Hoover as the Tip Top claim. They re-located it as the Lily May the following year and recorded their location in Nelson.

Although the gossan of Red mountain had attracted the attention of the earlier travellers along the Dewdney trail, some of whom, including Nelson Demers, had done a little work on it, the values were too low to warrant lode-mining in a wilderness, with its high cost for transportation and development; placer mining, consequently, absorbed their interest. It was not until 1890 that claims were located on the lodes which were to create the city of Rossland and to bring southern British Columbia prominently before the mining and commercial world.

In the summer of 1890, Bourgeois and Morris, who were working on the Lily May, crossed over to Red mountain and located in one day the Le Roi (then the Louis claim), Centre Star, War Eagle, Idaho, and Virginia. These claims were recorded at Nelson, the Le Roi being given to Colonel E. S. Topping, deputy mining recorder, for paying the $12·50 recording fees. (The old British Columbia mining law forbade the prospector staking more than one claim on the same vein.) He secured specimens and went to Spokane, interesting some business men of that town, headed by Oliver Durant, in the Le Roi, and the development of the camp began. The Spokane Syndicate acquired a bond on a sixteen-thirtieths interest for six months in the Le Roi for $16,000, and under the management of Durant proceeded to prospect the claim during the winter of 1890-1. The news of the strike brought prospectors, and the Josie and most of the other claims whose names became so familiar, were located shortly after the first discovery, many in the same month. A mining recorder's office was established in Rossland and about 50 men wintered that year (1890) in the camp.

Ross Thompson was the founder of the town of Rossland. While working as a miner in 1890 at the Centre Star mine under Oliver Durant, he located a pre-emption claim of 160 acres. Two years later he obtained a title to his claim; plotted it as a townsite and proceeded to erect buildings. Lots were sold at first for $30, but as building proceeded they advanced a little in price. The town was first called Thompson, but there being another town of the same name in British Columbia, the present name of Rossland was finally adopted.

The first ore sent out of the camp was a small lot, 10 tons in 1891, from the bottom of the Le Roi 35-ft. shaft. This ore was packed by mule to the Columbia river and thence shipped to a smelter in Butte, Montana. The returns showed values amounting to $84·60 to the ton, the assay being 3 oz. silver, 5·21% of copper, and about 4 oz. of gold to the ton. The bond was then taken up, and Mr. Topping's remaining interest acquired, by George Turner, Colonel Isaac Peyton, W. W. Turner, W. M. Ridpath, all of Spokane, and Alexander Tarbet, of Butte. Durant and Tarbet sold their interest about the same time and bonded the Centre Star and Idaho from the original owners. In the spring of 1892, sixty-seven mining claims, including the Josie, Jumbo, Monte Christo, and Columbia-Kootenay, were recorded and a wagon road was cut to Northport in the State of Washington. Durant and his partner Tarbet in 1892 spent $25,000 on work in the Centre Star mine which for the time being was the mainstay of the camp. The Le Roi Company succeeded in selling $25,000 worth of treasury stock in Danville, Illinois, for development purposes. During the same year, the Spokane Falls & Northern railway was completed from Spokane to Northport. Through the efforts of Oliver Durant, a trail, which was afterwards improved to a road, was built from Northport to the camp. Early in 1893, private individuals started, and the Government completed, 12 miles of wagon road from the landing at Trail on the Columbia river to the mines. During the same year, the War Eagle was bonded, but the bond was dropped. It was again bonded, but, on account of the workings being off the ore, was again dropped. It was finally bonded by Wakefield Corbin and others, who in 1894 took in P. Clark and associates. During this period the fortunes of the little camp were at a low ebb. Lack of transportation facilities, and the financial panic of 1893, were the chief deterrent factors that nearly wrecked the fortunes of the camp. Durant, who had overcome many obstacles and disappointments in developing and demonstrating the worth of his properties, was forced to give up for the time being. Fortunately the new wagon road to Trail enabled the Le Roi to ship 700 tons of ore that had accumulated on the dumps, and the returns from this made it possible to resume operations. In 1894, the Josie was purchased and P. Clark, having discovered the ore-shoot, paid up his bond on the War Eagle ($23,000). The shipments for the year amounted to 1856 tons of ore, which returned $75,510, freight and treatment costing $22 per ton. During the summer R. G. McConnell, of the Geological Survey, made a reconnaissance survey of the camp. Several of the more important properties were bonded for considerable sums and development was begun in earnest. The people grew to about 300 in the summer of 1894, but it was not until December of that year, when the great ore-shoot in the War Eagle mine was struck, that the people made up their minds that the camp would live.

The following year, 1895, was a year of great activity and the young camp received marked attention. The population rose from 300 to 3000, railway and smelting facilities were projected, and from that time forward development was rapid. Dividends were declared by the Le Roi and War Eagle, the latter mine paying its first dividend of $32,500 in February 1895. In seven months the War Eagle paid $132,000 in dividends. The most important event in 1895, however, was the contract made by the Le Roi mine with the late Augustus Heinze of Butte for 37,500 tons of ore at a freight and treatment rate of $11 per ton, and also for 37,500 tons on which the treatment charges should be the lowest obtainable in the open market. With this contract, a land grant from the Provincial Government, and a bonus of $1 per ton from the Dominion Government, Heinze built the Trail smelter, and a tramway from the smelter to the mine. Work was commenced in October and in the following February the first furnace was blown in. By June the tramway was in operation.

Writing of the development of Rossland this season, McConnell, in the Geological Survey Report for 1895, states: "The number of working mines has been largely increased, the known area of the mineral belt extended in all directions, a well built town of 2000 or more inhabitants has sprung up near the mines, and a second town is being built near the mouth of Trail creek. The shaft on the Le Roi is now down 380 ft., and the lode followed appears to be strengthening with depth. At the 350-ft. level, the ore-shoot has a length of 168 ft. and a width at one point of over 40 ft. The result of the workings on the Le Roi, the pioneer mine of the camp, has inspired confidence in the permanency of the numerous other less developed lodes in the district."

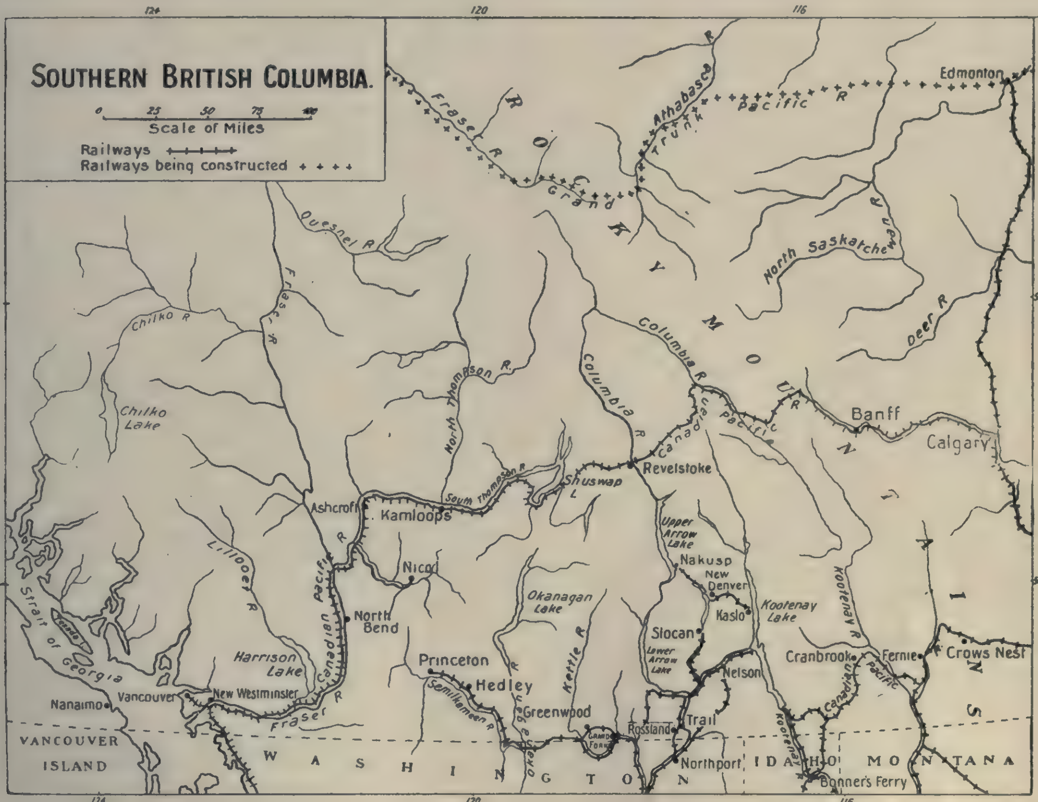
It was reported that in November of the same year the Cliff was sold for $150,000 and the St. Elmo for $75,000. The population increased faster than buildings could be erected, and by 1896 it had grown to about 4000. The construction of the Columbia & Western railway to Trail was completed in May 1895, making large regular shipments possible. The cost of freight and treatment in 1896 was about $10 to $14 per ton. At that time 95% of the assay-value of the gold and silver was paid for and the percentage of copper carried by the ore, less 1·3%. The coke for use at the smelter cost $17 per ton and was brought from Union Mines, Vancouver island.

In 1896, the Red Mountain railway, connecting Rossland with the Spokane Falls & Northern railway at Northport, was completed, giving standard-gauge connections with three transcontinental lines at Spokane. The shipping mines at this time were the Le Roi, War Eagle, Josie, Iron Mask, and Columbia-Kootenay.

Then came the inevitable wild boom. The evil effects of a boom are not confined solely to the thousands of dollars squandered in worthless property, the losses sustained by the innocents, and the damaged reputation of the district, but they are manifest in careless work on deserving claims, in a rash expenditure that may for some time survive the boom; in a loss of interest in properties of merit; and in a tendency to maintain prohibitive prices on promising prospects by owners who have purchased during the period of inflation and are not prepared to accept a serious loss, or by owners who, once having experienced the sensation of being millionaires, are loth to accept present conditions, but prefer to speculate on the improbabilities of the future. Rossland has been called on to pay in full all the penalties attaching to a boom. The phenomenal rise in the value of Le Roi stock, the dividends declared by this company and the War Eagle, and the sale of the latter to Toronto capitalists, for the reported sum of $700,000, produced a feeling of buoyancy that afforded every opportunity to the unprincipled boomster and the amateur mining magnate, the public for the time being cheerfully swallowing whatever was offered. The inevitable slump followed.

In 1897, Rossland had an estimated population of 6000 and was incorporated as a city. A broad-gauge railway was built from Trail to Robson, giving better connexion with the Canadian Pacific railway than was afforded by the Columbia river which is very rapid along this portion of its course. Stronger companies were formed to take over and develop promising prospects. In particular, the British America Corporation (Whitaker Wright) purchased the Josie, Nickel Plate, Great Western, Foorman, West Le Roi, No. 1, and Columbia-Kootenay mines. Development work had yielded most promising results. The Le Roi Company, having completed its contract for 75,000 tons with the Trail smelter, erected its own smelter at Northport with a capacity of 250 tons per day. In 1898, the Canadian Pacific railway purchased the Trail smelter and railway line from Heinze, and immediately reduced the smelting charges to $7·50 per ton. The operations on a large scale were projected. The construction of the West Kootenay Power Company's plant at Bonnington Falls, 32 miles distant, was another important event, making electric power available for the Trail smelter and the Rossland mines.

At the close of 1899, the reputation of Rossland suffered from the sudden collapse in the price of War Eagle stock. This stock had been run up to a wholly unwarranted point, and was held in the hope that new machinery would permit an increased output, with a resultant advance in the stock. Unfortunately the machinery proved a failure and the stock dropped. A general desire to realize followed and brought about



British America Corporation secured the Le Roi mine and smelter by purchasing the stock at a price which was said to represent nearly $4,000,000 for the property. The Le Roi had realized from its operations before the sale in 1898, $975,000 in dividends. The Centre Star was purchased by Messrs. Gooderham, Blackstock, Struss & Company of Toronto in the autumn of 1898 for the reported sum of $2,000,000 cash.

The construction of the Crowsnest branch of the Canadian Pacific, built through the Crowsnest coalfields to Kootenay lake, was an important event for the camp. It meant cheaper and better fuel and coke, and a consequent reduction in cost of ore production and treatment. These reductions brought about a large increase in ore tonnage with a corresponding diminution in the grade of ore mined. Large plants with the most approved machinery for the economical working of the mines were installed or planned, and a collapse, with a consequent loss of faith in the camp. In 1900 the Le Roi No. 2 Company was formed by the British America Corporation to acquire the Josie, Poorman, Annie and other claims. In 1901 came the Whitaker Wright collapse, and the transfer of the control of the Le Roi and Le Roi No. 2 companies to other parties in England. In 1901, Rossland received another set-back, this time in the form of labour troubles, which closed up the mines for a part of the year. These difficulties were amicably adjusted, but the evil effects of such troubles in discouraging investments are not quickly effaced. By 1902 the mines had resumed their normal operations and on a more business-like basis than before. Experiments in concentration were commenced in 1903 and are still being made, and serious efforts are being made to obtain the greatest possible profit per ton of ore.

In 1906, the Centre Star Mining Company and

War Eagle Consolidated Mining & Development Company were amalgamated by the Consolidated Mining and Smelting Company of Canada, which company in 1911 acquired the Le Roi, Black Bear, and Le Roi Star fraction claims. The latter properties were for many years owned and operated by the Le Roi Mining Company. During the first six months of 1912 a coal strike in the Crowsnest pass and the consequent high price of coke imported from Pennsylvania increased by about $120,000 the operating expenses of the Trail smelter. At the close of the strike the cost of electric power was increased to an extent which increased expenses approximately $40,000 annually. The improvement in the grade of the Rossland ore, however, and new developments in the War Eagle and Le Roi mines have more than offset this extra expense. The Consolidated Company in 1912 acquired the Monte Christo, Iron Horse, Abe Lincoln, and Virginia claims. Threatened litigation between the Le Roi No. 2 Company and the Consolidated Company was settled in 1913 by mutual agreement and concessions. New machinery has been installed at the Centre Star, War Eagle, and Le Roi mines and shipments now aggregate 1000 tons daily. In 1914 the Consolidated Company purchased the Mabel, Paul Boy, Eddie J., and the Annie E. claims, one-fifth interest in the Pilgrim claim, and the property of the Canadian Goldfields Syndicate in Rossland, chief of which were the Sunset No. 2, Alabama, Gold Hunter, and Jennie mineral claims.

THE MARCY BALL-MILL.

On several occasions during the last twelve months reference has been made in our columns to a new type of ball-mill invented by F. E. Marcy, and in use at a number of gold and copper mines in America. By means of a screen interposed across the whole width of the cylinder near the discharge end, it is possible to remove fine material much more rapidly than with the ordinary trunnion discharge. In the language of the concentration specialist, the discharge in the Marcy mill is at a lower level than the feed. In these days when the claims of the ball-mill against those of the stamp are being seriously considered, and when important mines are experimenting in this direction and in some cases have already adopted this type of ball-mill, it is desirable to give some information following this modern trend of practice. *Metallurgical and Chemical Engineering* for March 1 publishes an article on the 'Development of a Modern Ball-Mill.' The author refers to the Hardinge mill, and argues that, as its action is based on classification rather than sizing, the more friable sulphide minerals are ground too finely. The same holds good for short tube-mills without screens. The Ferraris mill is held to have embodied the ideas of the most recent types, though a defect in the design prevented it from coming into use. The inventor was Erminio Ferraris, of the Monteponi lead-zinc mine, Sardinia. This mill consisted of a revolving cylinder divided into two compartments by means of an annular perforated partition. The larger or crushing compartment was lined with ribbed steel plates and contained steel balls, from 3 to 6 in. diameter. The smaller or screening compartment was divided into a series of pockets by means of radial partitions extending from a frustum of a cone that projected back into the crushing compartment. The periphery of the screening compartment was surrounded by a screen of the desired mesh. When the ore was ground fine enough to pass the perforations of the annular partition, it flowed into the screening compartment and out through the peripheral screen into a housing surrounding the lower half of the compartment. The particles that were not small enough to pass the screen were carried back by the cone into the crushing compartment. In the light of later experience, the failure of this mill in practice was due to the fact that the oversize was returned at a point where there was little chance for further grinding. Had the entire pulp, after passing the annular partition, been screened outside the mill and the oversize returned at the feed end, there would have been effective re-grinding. But when it was returned to a point just inside the annular partition there was no opportunity for further grinding, as the oversize immediately short-circuited through the partition and accumulated until the mill was choked. The Ferraris mill may, however, be regarded as the prototype of the modern short ball-mill with the perforated partition, low discharge, and radial lifters. If it had not been for the failure to recognize the necessity for outside screening and the return of oversize at the feed end, the short ball-mill might have arrived earlier.

The Marcy patent rights for America are held by the Mine & Smelter Supply Company, of Denver. Parenthetically we may mention that ball-mills constructed on similar principles are made by the Allis-Chalmers Company and by Chalmers & Williams, and that the F. M. Davis Company, the predecessor of the Mine & Smelter Supply Co., was the American agent for the Ferraris mill.

A typical Marcy ball-mill is 8 ft. in diameter by 6 ft. in length. The interior is divided into two compartments by an annular grating of manganese steel, near to the discharge end. In the discharge compartment there is a series of pockets formed by radial lifters corresponding to the sectors of the grating, much the same as in the Ferraris mill. The grating has linear openings ⅛ in. wide or less, increasing in width toward the discharge compartment. The feed end of the mill is fitted with scoop feeders which deliver the ore to the grinding compartment. When the ore is crushed fine enough to pass the grating it flows into the discharge compartment where it is lifted by the radial bars and discharged through the trunnion. In this respect the Marcy mill differs radically from the Ferraris, for the entire pulp is removed from the mill for screening or classification, and the oversize is returned with the original feed. Due to the ease with which ground particles pass through the grating, and the rapidity with which they are removed by the lifters, the level of discharge from the grinding compartment is much lower than that of the feed, and as a consequence mineral and quartz particles are removed from the grinding zone with equal facility, and almost as soon as they are ground. This obviates the unnecessarily fine grinding which occurs in a mill with trunnion discharge on about the same level as the feed, wherein the particles have to rise to a high level in order to flow out.

Mills of this type are now being constructed that will take feed as coarse as 4 in. in diameter and deliver a product of 40 or 50-mesh. This makes it possible to eliminate some of the machines heretofore considered necessary in stage crushing in order to reduce ore fine enough for concentration. The best efficiency has been obtained with about 40% moisture in the pulp. The 8 ft. by 6 ft. mill has a capacity of 1000 tons per twenty-four hours, grinding to 10-mesh; 750 tons to 20-mesh; 350 to 400 tons to 60-mesh. The power requirement is from 200 to 225 hp., and the ball load from 9 to 10 tons. The balls range in size from 5 in. diameter, weighing 20 lb., to 2½ in. in diameter. The Inspiration Consolidated Copper Co. has installed forty of these mills, each having a capacity of from 350 to 400 tons per day, taking crusher feed as coarse as 2½ to 3 in. and delivering a product that will pass a 48-mesh screen. The Arizona Copper Co., with headquarters in Edinburgh, has also adopted the Marcy mill. These mills are in closed circuit with classifiers which deliver the oversize back to the feed end. The cost of crushing, including power, oil, maintenance, etc., is stated to be less than 15 cents per ton, and it is hoped eventually to reduce this to 10 cents per ton. The metal consumption of balls used in treating copper ore has been proved to amount to about 0·6 to 1 lb. per ton, while the lining consumption is about one-tenth of this amount.

Electric Smelting.—At the March meeting of the Institute of Metals, a paper was presented by Dr. Alfred Stansfield, professor of metallurgy in the McGill University, Montreal, entitled, 'Electric Furnaces as Applied to Non-Ferrous Metallurgy.' This contains a useful review of progress in electric methods, both electrolytic and electrothermic, for reducing metals from their ores.

Owing to the great cost of electric heat as compared with fuel heat, its application to such comparatively cheap metals as iron and steel would not necessarily be expected. Nevertheless this method of smelting has been largely applied to their production, and a great proportion of general experience gained has been derived from this source. There are three other classes of ore and metal that would appear to be more immediately suitable for electric treatment, namely: (1) easily oxidizable metals such as sodium, magnesium, and aluminium, which are produced by the electrolysis of fused salts; (2) tungsten, molybdenum, and silicon (considered as a semi-metal by the steel metallurgist), which require extremely high temperatures for their reduction or fusion; (3) zinc and cadmium, which, though reducible at moderate temperatures, must be completely excluded from contact with the products of combustion of fuel. Dr. Stansfield discusses the methods applied, or proposed to be applied, to the production of aluminium, sodium, zinc, copper, and tin, but as these are fairly well known to our readers, we will not reproduce this part of the paper here. We give some extracts relating to the less common metals.

Magnesium is a metal of great importance at present, owing to its use in the manufacture of flares employed for illuminating the battlefield at night, being an extension of its use for flash-light photography. It is also employed in the form of an alloy with aluminium, and as a deoxidizer in the production of bronzes and similar alloys. It is generally produced by the electrolysis of the fused chloride, and before the war was made almost entirely in Germany, where the raw material carnallite is found in the Stassfurt deposits. Since the outbreak of war, plants have been started in England, Canada, and the United States for the production of magnesium.

Silicon is produced by the Hafslund Sulfit-fabrik, Larpsborg, Norway, by the Bosnische Electricitäts Gesellschaft, Jaice, Bosnia, Austria, and by the Carborundum Company at Niagara Falls. At the last named place, the output is 1500 tons per year. Silicon is used in steel manufacture, and, on account of its resistance to acids, in the chemical industry. It may be employed instead of aluminium in Goldschmidt's thermit process. It is produced in the arc furnace by the reaction of carbon on silica at a temperature of 1460°C or over. The reaction is beset with difficulties owing to the volatility of silicon and the formation of silicon carbide. In the form of ferro-silicon it is produced on a much larger scale, and at the present time 60,000 tons per annum is made in the United States and 20,000 tons in Canada for the use of steel manufacturers. Dr. Stansfield makes no reference to European production. The usual grades contain 50, 75, and 90% silicon respectively.

The output of molybdenum, mostly as ferro-molybdenum, is estimated at 100 tons per year. It is obtained by roasting the sulphide, molybdenite, and reducing it in the electric furnace. Owing to the difficulty of completely roasting the sulphide and to the volatility of the oxide, an alternative process has been proposed, consisting of smelting the sulphide with lime and carbon, the function of the lime being to abstract the sulphur. Molybdenum would be more extensively used in steel alloy manufacture were it not for the fact that it causes seams in the steel ingots. Not a quarter of the molybdenum steel made is free from these seams, so that the cost of production of the steel is raised to an almost prohibitive price.

About 1500 tons of ferro-vanadium is made per year, averaging 40% vanadium. In America the aluminothermic process is used, and in Europe the electric furnace. Ferro-chrome to the extent of 50,000 tons per annum is produced in the electric furnace in America and Europe. Ferro-titanium is produced extensively and it is said that titanium is useful for cleaning steel as it combines with both oxygen and nitrogen; but reliable independent information on the subject is not available.

Ferro-tungsten is produced in the electric furnace, and a portion of the metallic tungsten also. The total production of the metal, in both forms, is about 4000 tons per year.

Tin in 'German' South-West Africa.—In his report on the geology and mineral industry of 'German' South-West Africa, mentioned in our book reviews, P. A. Wagner gives some notes on the occurrence of tin in that province. The deposits so far observed are found in a belt lying in a northwest-southeast direction, to the north of Karibib, a station 160 miles from Swakopmund, on the line to Windhoek. The southern portion of the region is occupied chiefly by the Erongo mountains, and the tinfield is accordingly known as the Erongo tinfield. The first discovery was made at Ameib, below the southern escarpment of the Erongo range. Owing to the bare nature of the land, prospecting was easy, and deposits were soon found at Dawib, Aubinhonis, Tsomtsaub, Neineis, Uis, Kawab, Otjumue, and Kohero. At all these outcrops, the cassiterite is in veins and lenticular bodies of pegmatite, intrusive into the ancient schists, and related genetically to the older granites of the Erongo area. Cassiterite is also found in veins of aplite and pegmatitic quartz. The pegmatite is usually a coarse-grained rock of greyish-white colour, and consists essentially of quartz, felspar, and pale greenish-white muscovite. In addition to cassiterite, the following minerals are found in the pegmatite: tourmaline, garnet, magnetite, apatite, beryl, wolframite, monazite, columbite, molybdenite, and lepidolite. Cassiterite and tourmaline appear to exclude one another mutually, for the pegmatite rich in cassiterite is poor in tourmaline, and vice-versa. Geological examination indicates that tourmaline was formed in the vicinity of the parent granite and cassiterite farther away. The cassiterite is sporadically scattered through the pegmatite in large grains and crystalline masses. The latter are often big, as is evidenced by the fact that a solid mass weighing 550 lb. was found at Dawib. The cassiterite is usually yellowish brown in colour, and is remarkably pure. In the southeastern end of the belt, ruby tin is found. The cassiterite appears in some cases to have crystallized at the same time as the other constituents of the pegmatite, but in other instances it is obviously of later origin, being developed along cracks in the pegmatite. In the latter cases, it is evident that the cassiterite and its accompanying muscovite have replaced the original quartz and felspar. Some of the larger veins of pegmatite enclose tabular masses of pegmatitic quartz containing cassiterite. This cassiterite is usually found along the contact between the pegmatite and the pegmatitic quartz, and it is noteworthy that the pegmatite then carries no cassiterite. The veins so far developed have usually proved to be poor and patchy, and disappear at a comparatively short distance from the surface. The results of mining have therefore proved disappointing. The only successful showing was at the Kohero East mine, which had yielded 120 tons of concentrate before the war. The orebody had been opened to a depth of 92 ft., at which point the pegmatite disappeared. Below this point, the mica-schist is finely impregnated with cassiterite and tourmaline along the line of fissure, and probably further pegmatite bodies may be found below. Detrital deposits are found at many points, where the cassiterite occurs in sub-angular and rounded grains and fragments. Fairly good results have been obtained in some cases, but on the whole the deposits are poor and of restricted extent. The usual method of exploitation consisted in excavating by pick and shovel, screening, and concentrating in hand-jigs. At Chatputz, a storage dam was built for hydraulicking purposes, but this was destroyed during the recent campaign. Dr. Wagner also mentions in his report the occurrence of wolfram in the southeast part of the territory, to the south of Keetmanskop. The wolfram occurs in narrow veins traversing gneiss and gneissic granite. Though rich patches are found occasionally, the deposits have been too poor for systematic work. Much mining has been done on the properties by the South African Territories Limited, an English company.

Electrolytic Zinc. — In the *Engineering and Mining Journal* for March 4, W. R. Ingalls has something to say regarding the production of zinc by electrolytic methods. The present high price of zinc has stimulated the use of wet methods for the treatment of zinc ore and concentrate, because it is possible to erect and start an electrolytic plant in a much shorter time than a smelting plant provided that the source of electric power is readily available. Moreover the amount of skilled labour required is much less with the electrolytic plant. But the cost of current is generally against the electrolytic method. When zinc comes back to a normal price, the fire method will no doubt again assert itself. Mr. Ingalls points out that the present position of the electrolytic method differs from that of twenty years ago when failures were recorded. In those days, crude complex ores were treated, whereas nowadays the material is fairly clean concentrate. The old difficulty due to the zinc being deposited in spongy form, which is easily reoxidized and for that reason troublesome to melt, has largely disappeared under the altered conditions. Mr. Ingalls refers to the electrolytic process adopted by the Anaconda company, which is erecting plant at Great Falls with a capacity of 35,000 tons of zinc per year. This process has been evolved with the object of getting rid of the iron, a constituent of blende that causes trouble in the electrolytic process. According to the new method, the ferrous sulphate in the solution obtained by the leaching of roasted zinc concentrate with sulphuric acid is converted to the ferric state by agitation with a manganese compound, which characteristically provides the required oxygen. The iron is then easily precipitated from the solution in the form of ferric hydrate. Lead and silver are precipitated at the same time. The solids are removed by filters, and the cake, containing iron, lead, and silver is sent to the blast-furnaces. The solution still contains copper and cadmium, and to remove these, the solution is passed through a tube-mill containing zinc balls. The purified solution is electrolysed in vats for the precipitation of zinc. The electrodes are unsoluble, the anodes lead and the cathodes aluminium. The electrolytic action reoxidizes the manganese compound, which can be used over again. It is stated that the zinc produced is of the highest grade, averaging 99·9%. Further working details are required to complete this outline sketch of the process, and no doubt the metallurgists at Anaconda will oblige when the right time comes.

Pulverized Coal as Fuel.—In our last issue we gave an abstract of a paper by C. R. Kuzell, of Anaconda, on 'Coal-Dust Firing in Reverberatory Furnaces.' We have been asked by many readers for the bibliography which we mentioned as being appended to Mr. Kuzell's paper. As we believe that this method of burning coal is likely to attract general attention in the near future, we reproduce the bibliography herewith:

Coal-Dust Firing in Reverberatory Matting Furnaces, S. Severin Sorensen. *Engineering and Mining Journal*, February 10, 1906.

Coal-Dust Firing for Reverberatory Furnaces, Charles F. Shelby. *Engineering and Mining Journal*, March 14, 1908.

The Use of Pulverized Coal in Metallurgical Furnaces, James Lord. Proceedings of the Engineers' Society of Western Pennsylvania, October 1913.

Pulverized Coal as a Fuel. *Engineering and Mining Journal*, May 16, 1914.

Coal-Dust Firing at Anaconda, E. J. Carlyle. *The Mining Magazine*, September 1914.

Pulverized Coal in the Cement Industry, R. C. Carpenter. Journal of the American Society of Mechanical Engineers, October 1914.

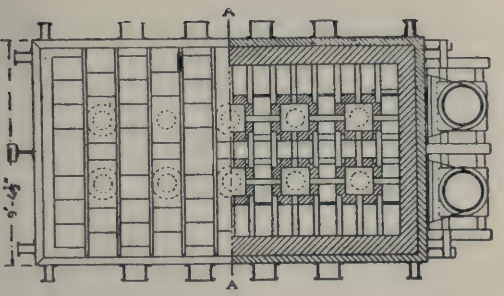
Coal-Dust Fired Reverberatories at Washoe Reduction Works, Louis V. Bender. Bulletin of American Institute of Mining Engineers, February 1915.

Coal-Dust Reverberatory Furnaces of Canadian Copper Co., David H. Browne. Bulletin of American Institute of Mining Engineers, February 1915.

Discussion of Papers on Coal-Dust Fired Reverberatory Furnaces. Bulletin of American Institute of Mining Engineers, May 1915.

Anaconda Coal-Pulverizing Plant, E. P. Mathewson. *Engineering and Mining Journal*, July 10, 1915.

Contribution to Symposium on the Utilization of Fuels in Metallurgy, E. P. Mathewson. International Engineering Congress, San Francisco, 1915.



Plan of Rittman Furnace used for Cracking Petroleum.

Pulverized Coal for Copper Smelting, N. L. Warford. *Mining and Engineering World*, November 6, 1915.

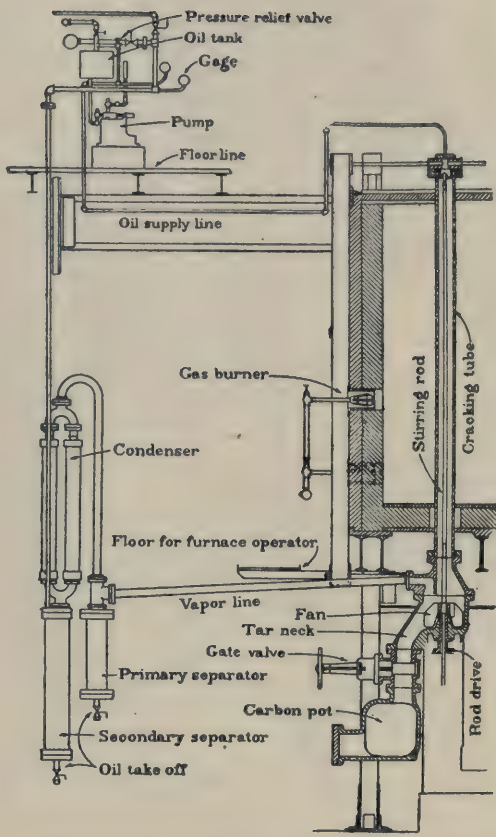
Coal - Dust Firing in Reverberatory Furnaces, C. R. Kuzell. Second Pan-American Scientific Congress, Washington, 1916.

Pulverized Coal, Its Preparation and Use in Industrial Furnaces, S. H. Harrison. *The Engineering Magazine*, February 1916.

Melting Point of Coal Ashes, E. J. Constant. *Journal of Gas Lighting*, vol. 124, p. 572.

Prevention of Dust in Mines.—*The Iron and Coal Trades Review* for March 24 contains an article describing a method of settling dust in mines and preventing its disturbance by blasting or by explosion, introduced by the Belger Colloid Dust Treatment Company, of Newcastle-on-Tyne. It is intended particularly for use in coal mines as an alternative to the recently recommended method of stone-dusting. Demonstrations have been publicly given in Durham and South Wales, and officials of the Home Office and the Miners' Federation have expressed an interest in the results obtained. According to this system the workings are sprayed with a solution of calcium chloride mixed with a sticky material prepared from fish glue. Calcium chloride is noted for its hygroscopic qualities and has often been used for keeping things damp; but this very property nullifies the effect, for the attracted water runs away or drops, and so removes the effective chemical. The fish glue is added to the solution so as to form a colloid, which adheres and so retains the chemical in place for a much greater time. The vessel containing the mixed solution travels on a mine car connected with the compressed air system, and the solution is sprayed from an atomizer at a pressure of 50 lb. A stretch of 50 yards that had been treated in this way at the Washington colliery, Durham, 22 months ago, was shown to the official visitors, and it was found to be still moist.

Cracking Petroleum by the Rittman Method.—In June of last year in an article on explosives we referred to the new method of producing petrol, benzene, toluene, and other members of the aromatic series from petroleum. These experiments have been conducted by the United States Bureau of Mines, which owns the covering patents and is prepared to grant licences. The Aetna Chemical company, of Pittsburgh, is working the process for the manufacture of benzene and toluene, and these products are used in the manufacture of high explosives. Briefly the method consists of subjecting petroleum to extremely high pressures and temperatures, at or about the 'critical' temperature, that is to say the temperature at which the compound cannot exist as a liquid however great the pressure. The retorts are arranged vertically and are



Vertical Diagrammatic Sketch of Rittman Furnace used for Cracking Petroleum.

made of steel, aluminium-lined, being 10 ft. high, 8 in. diameter, and 1 in. thick. Ten tubes spaced conveniently apart are built into a brick furnace and kept in place by an internal brick chequerwork. The oil is forced in at the top by pumps, and is spread out by a baffle to the inside surface of the tubes. Here it is immediately volatilized. On their way farther down the tubes the gases are submitted to greater heat and are cracked. The resulting gases are drawn by fans through condensers where the hydrocarbons liquifiable at ordinary temperatures are recovered and the permanent gases are led to storage. In the reaction in the retorts carbon is deposited, and this is removed by a central stirring rod. The furnaces are heated by gas, and the number of burners and the amount of gas used are regulated according to the heat required. When benzene and toluene are made sufficient gas is evolved in the reaction to feed the burners; but in the manufacture of petrol, the amount of gas evolved is smaller and outside supplies have to be obtained. The pressure throughout the plant is regulated by the discharge valve. The pressure required for producing the largest amount of benzene is 250 lb. per square inch, and for toluene 170 lb. When petrol is made the pressure employed is 300 lb. The above information is taken from an article in *Metallurgical and Chemical Engineering* for March 1 based on advance sheets of Bureau of Mines Bulletin No. 114 now in preparation.

TECHNICAL JOURNALS FOR THE MONTH

British.

Association of Mining Electrical Engineers (West of Scotland Branch).—*March 18:* Types of Modern Electric Winding, Frank Anslow.

Chemical Society.—*March 16:* Influence of Pyrite on the Oxidation of Coal, T. J. Drakely.

Coke-Oven Managers Association.—*March 25:* Effect of Salt in Coal on the Fire-clay Linings of Coke-Ovens, J. W. Cobb.

Colliery Guardian.—*March 10 and 17:* Campine, Belgium, Coalfield, P. Krusch (from *Glückauf*); Estate Management and Mineral Valuations, G. Turville Brown, paper read before the Surveyors' Institution. *March 17:* Jeffrey Centrifugal Mine Fans; Safety Catches on the Cage, N. T. Williams. *March 24:* Coal-washing Plant constructed of Reinforced Concrete; Electric Winding Plant at Pumpherston Oil-Shale Mine, Scotland.

The Engineer.—*March 10:* Belgian Industries before and during the War—V., H. Hubert. *March 24:* Glass Research; British Machinery and the Russian Market, P. Gurewitch; The Medlow Dam, Blue Mountains, New South Wales. *March 31:* Economic Extraction of Tin and Tungsten from Cornish Ores.

Faraday Society.—*March 15:* Methods and Appliances for the Attainment of High Temperatures in the Laboratory, J. A. Harker, Sir Robert Hadfield, and others.

Geological Magazine.—*March and April:* Application of Petrological and Quantitative Methods to Stratigraphy, P. G. H. Boswell.

Institute of Metals.—*March 29:* Electric Furnaces as applied to Non-Ferrous Metallurgy, Alfred Stansfield; Transformations in Alloys of Gold with Copper, N. Kurnakow, S. Zemczuzny, and M. Zasedatelev; Electrolytic Method of Preventing Corrosion, Elliott Cumberland; Analysis of Aluminium and its Alloys, W. H. Withey; Some Tin-Aluminium-Copper Alloys, A. A. Read and R. H. Greaves; Annealing of Nickel-Silver, Part I, F. C. Thompson; Third Report of the Corrosion Committee, W. E. Gibbs, R. H. Smith, and G. D. Bengough.

Institution of Petroleum Technologists.—*March 21:* The Natural Gas Industry, its Progress and Importance, J. A. L. Henderson.

Iron and Coal Trades Review.—*March 10:* Report of discussion on the Use of Blast-furnace Slag in Cement Manufacture; Ownership of Iron Ore Mines of French Lorraine, in the Briey district, occupied by the German forces. *March 17:* Old Tubes for Pit Props. *March 24:* Belger System of Deadening Coal Dust in Mines; Coal-face Conveyors, James Jackson.

Manchester Geological and Mining Society.—*March 14:* Use of Carbonic Acid for Extinguishing Mine Fires, E. C. Evans.

Midland Institute of Civil, Mining, and Mechanical Engineers.—*March 21:* Pit Timber and its Preservation, Percy Groom.

Mining Journal.—*March 11:* Mining Conditions in British Guiana; The Spelter Problem and the War, J. Gilbert. *March 25:* Wolframite Mining in Tavoy District.

National Association of Colliery Managers, Scottish Branch. *February 26:* Use of Wire-Rope Guides for Pit Cages, William Rose.

National Association of Colliery Managers (Yorkshire Branch).—*March 11:* Auxiliary Ventilation, J. Ensor and others.

North Staffordshire Institute of Mining and Mechanical Engineers.—*March:* Quality of Iron and Steel for Colliery Work, W. Simons.

Royal Society of Arts.—*March 27:* Surveying, Past and Present, E. A. Reeves.

Staffordshire Iron and Steel Institute.—*March 25:* Blast-furnace Working and the Function of Slags, J. E. Fletcher.

Colonial.

Canadian Mining Institute Bulletin.—*February:* The Coal Situation in Canada, W. J. Dick; Some Conditions affecting Education in Mining and Metallurgy, J. C. Gwillim. *March:* The Flotation Process, T. A. Rickard; Concentration of Canadian Molybdenite Ores, H. E. Wood; The Copper Situation in Canada from the Point of View of the Consumer, G. C. Brown.

Canadian Mining Journal.—*February 15:* Adverse Editorial Criticism of F. G. Clapp's Report on 'Petroleum and Natural Gas Resources of Canada—Part II'; The 'Carr' Bit for Rock-Drills, as used at the Calumet & Hecla mines. *March 1:* Proposed Canadian Tax on Mining Profits; Improved Ore Chute at Sudbury Mines, A. E. Hall.

Queensland Government Mining Journal.—*February:* Boulder West Mine, Gurrumbah Tinfield, E. C. Saint-Smith; Devon Wolfram Mine, Coolgarra, E. C. Saint-Smith.

South African Mining Journal.—*January 29:* Some Features of the Rand Gold Mining Industry [concluded], W. A. Caldecott; Unhealthy Conditions in the Rand Mines and the Effect on Working Costs, G. H. Blenkinsop. *February 5:* Distribution Plant of the Johannesburg Municipal Electric Supply System [continued], J. H. Dobson. *February 12 and 19:* Report of the Committee on Earth Tremors on the Rand. *February 19:* Mining Prospects in Namaqualand, A. W. Rogers: Electrochemical Industries for South Africa.

Foreign.

American Institute of Mining Engineers Bulletin.—*March:* Flotation Concentration at Anaconda, F. Laist and A. E. Wiggin; Automatic Mine Hoists at Inspiration, H. Kenyon Burch and M. A. Whiting; Laboratory Methods of Determining Capacities of Slime-Settling Tanks, H. S. Coe and G. H. Clevenger; Methods of Refining Cyanide Precipitate at Liberty Bell, A. J. Weinig; Mine Accounting at Small Mines, J. E. Chapman.

Economic Geology.—*December:* Petroleum Resources of the United States, Ralph Arnold; Geology and Ore Deposition at Tonopah, Nevada, J. E. Spurr; Note upon the Occurrence of Mercury in Cobalt Ores, G. H. Clevenger.

Engineering and Mining Journal.—*February 19:* Gold Lake District, east of Lake Winnipeg, Canada, G. A. Packard; Mining in Ecuador, J. W. Mercer; Storing and Handling Explosives in Mines, C. E. Munroe. *February 26:* Recent Progress in Electrical Smoke Precipitation, F. G. Cottrell. *March 4:* The International Smelter at Miami, Arizona, H. W. Kerns; Electrolytic Zinc, W. R. Ingalls; Sedimentation and Flocculation, E. E. Free. *March 11:* Operations at Slocan, British Columbia, Douglas Lay. *March 18:* Method of Determining Dust Loss at the Copper Cliff Smelter of the Canadian Copper Co., E. H. Robie; Sedimentation and Flocculation, E. E. Free; An Automatic Pulp Sampler, R. B. Elder.

The Engineering Magazine.—*March:* Stripping Overburden in Open-cut Mining, L. O. Kellogg; Fuel Oil from Shale, A. Selwyn Brown.

Franklin Institute Journal.—*March:* Smoke as a Source of Atmospheric Pollution, W. F. M. Goss.

Metallurgical and Chemical Engineering.—*March 1:* The Power Famine at Niagara Falls; Electrochemical War Supplies; Operations of the Blast-Furnace [continued], J. E. Johnson, Jr.; Production of Petrol, Benzene, and Toluene by Rittman's Process; Counter-Migration of Pulp and Solution in Leaching, Bernard Macdonald; Development of the Marcy Ball-Mill. *March 15:* Concentration Methods on Colorado Tungsten Ores, H. C. Parmelee; Potash from Seaweed, I. F. Laucks; Raw Materials of the Blast-Furnace, J. E. Johnson, Jr.; Hydrogen for Military Purposes, E. D. Ardery.

Mining and Engineering World.—*February 19:* Gold-Quartz Replacements in Intrusive Rocks, particularly with regard to deposits near the head waters of the Feather river, California, John F. McLennan; Cable-way of the Asbestos Corporation of Canada, S. R. Stone. *February 26:* Mining Operations at the Copper Queen, Arizona, J. P. Hodgson; The Increasing Use of Low-grade Phosphates, James A. Barr. *March 4:* Wyoming's Great Fuel Resources, Gas, Oil, and Coal, H. W. Seaman.

Mining and Scientific Press.—*February 19:* Stoping Methods, F. W. Sperr; Refining Cupriferous Precipitate, J. A. Pearce; Flotation Principles, C. T. Durell; Quicksilver Mining in California, W. H. Landers. *February 26:* Coarse Concentrator and Flotation Plant at Anaconda, L. S. Austin; Drill Shanks and Bits, P. B. McDonald; On the Science of a Froth, W. H. Coghill. *March 4:* The Flotation Process—I.: Physics, T. A Rickard. *March 11:* Antimony in China, F. L. Cole; The Electrostatics of Flotation, F. A. Fahrenwald.

NEW BOOKS AND OTHER PUBLICATIONS

The Metallurgy of Iron. — By Professor Thomas Turner. Cloth, octavo, 480 pages, illustrated. London: Charles Griffin & Co. Price 16s. net. For sale at the Technical Bookshop of *The Mining Magazine.*

Nominally, this Magazine is supposed to interest itself solely with the non-ferrous metals, and to have a similar scope to that of the Institution of Mining and Metallurgy as expressed in the wording of its Royal Charter. But nowadays the gold and copper man invades other fields of activity, and is interested in the ores of tungsten, molybdenum, and manganese, and the copper metallurgist finds that he must keep in touch with the treatment of iron, for instance in connection with dry blast, electric smelting, and the utilization of the heat of slag. We have observed during the last few years a growing inclination on the part of our own circle of friends to seek literature relating to the metallurgy of iron and steel. The publication of a new edition of Turner's 'Metallurgy of Iron' comes at an opportune moment. The book is one of Griffin's metallurgical series written by associates of the Royal School of Mines. The author is the professor of metallurgy in the University of Birmingham, and he was one of the founders of the Institute of Metals. The first edition appeared in 1895, and it has been held steadily in repute. The first chapters gave a history of the uses and methods of producing iron and steel; then the ores and their preparation are described. Several chapters are devoted to the blast-furnace, its operation, the theory of reactions, fuel employed, and the gaseous by-products. A chapter is given on slags and fluxes. Afterward come chapters on cast iron and foundry practice, wrought iron and the puddling process, the further working of wrought iron, and the corrosion of iron and steel. A final chapter reviews many details of recent progress. Except for the appropriate reference in the historical account of metallurgical advance, steel is not included in the author's subjects. This branch of the metallurgy of iron is treated in the companion book of the series by Harbord and Hall. A feature of Professor Turner's method that we like is the judicious manner in which he gives references. He remembers that workers have limited facilities for referring to original authorities and to places where greater detail can be secured, and he accordingly quotes such publications as the Iron & Steel Institute Journal, and other well known and accessible books or transactions published in this country.

The German African Empire. By Albert F. Calvert. Cloth, octavo, 340 pages, with maps and photographic illustrations. London: T. Werner Laurie, Ld. Price 6s. net. For sale at the Technical Bookshop of *The Mining Magazine.*

Mr. Calvert's new book is a useful addition to our library, for it gives a convenient outline of the history of the four German provinces in Africa, South-West, German East, Togoland, and the Cameroons, together with brief accounts of their trade value, prospects, and opportunities. As regards individual colonies, our readers are already fairly well acquainted with the first two, but easily accessible records of Togoland and the Cameroons are scarce, so that Mr. Calvert's book will be welcome.

Geology and Ore Deposits of Rossland B.C. By Charles W. Drysdale. This is Memoir 77 of the Canadian Geological Survey, and describes a gold-copper region at one time prominently before the British public. The Le Roi No. 2 company is still doing excellent work on its complicated system of veins characteristic of these ore deposits. The Le Roi (No. 1) has been of recent years worked in conjunction with the Centre Star and War Eagle mines by the Consolidated Mining & Smelting Company of Canada. The present memoir gives a full physiographical, geological, and mineralogical account of the region, with details of the various mines. It contains also a history of mining operations, which we quote elsewhere.

Geology and Mineral Industry of South-West Africa. By P. A. Wagner. This is Geological Survey Memoir No. 7 published by the Union of South Africa. It describes the geology and the mineral deposits of 'German' South-West Africa. We published an article on this subject in our issue of August last covering the same ground. Dr. Wagner is a specialist on diamond deposits. We reviewed his book on 'Diamonds in Africa' in April 1914, and made extracts therefrom in November 1914. Additional information relating to the diamond industry was given by C. W. Boise in June 1915. We feel therefore that the 'German' diamond fields and the geology of 'German' South-West Africa have already received sufficient attention in our pages. Dr. Wagner gives some information relating to tin deposits, which we quote elsewhere in this issue.

Products and By-Products of Coal. By Edgar Stansfield and F. E. Carter. A publication of the Department of Mines of Canada, giving an outline of coking processes and the recovery of by-products.

Salt Deposits of Canada and the Salt Industry. By L. Heber Cole. This publication, issued by the Department of Mines of Canada, describes the salt deposits throughout the Dominion, and gives outlines of the theories of the origin of salt and of the technology of salt manufacture.

Electrothermic Smelting of Iron Ores in Sweden. By Alfred Stansfield. This report, published by the Canadian Department of Mines, describes the author's personal investigations into Swedish methods of smelting iron ores in the electric furnace.

Mineral Resources of Great Britain. Three reports have been published by the Geological Survey, describing the occurrences of ores and minerals in this country. In our last issue we quoted from the report on tungsten and manganese. Other reports deal with barite and witherite, and with gypsum, anhydrite, celestine, and strontianite.

Bibliography relating to Flotation. A bulletin published by the School of Mines and Metallurgy of the University of Missouri contains a bibliography of references to the process of concentration by flotation, compiled by Jesse Cunningham, librarian.

Ardlethan Tinfield. A report on the mineral resources of the Ardlethan tinfield, New South Wales, prepared by J. R. Godfrey, Inspector of Mines, for the New South Wales Geological Survey.

Year-Book of the Scientific and Learned Societies of Great Britain and Ireland. The thirty-second annual number of this useful reference book, published by Charles Griffin & Co., contains the usual information as to the constitution and the officials of the various societies, together with a record of the papers read during the year. The price is 7s. 6d. net.

Russian Reading Made Easy and **Russian Grammar Simplified** are the titles of two series of pamphlets published by Hugo's Institute for Teaching Foreign Languages. These can be recommended to learners of the Russian language. A special feature is the attention given to pronunciation.

The Rubber Handbook, published by *The Financial Times* at 1s. net, gives official information concerning a selection of young producing companies operating in Java and the Malay States.

The Porcupine Gold Area. This is a valuable report by A. G. Burrows, published by the Ontario Bureau of Mines, outlining the geology of Ontario in general and the Porcupine district in particular, together with details of the individual mines. We quote from this report on another page.

Transactions of the Canadian Mining Institute, 1915. This volume contains thirty excellent papers, chiefly those presented at the annual meeting, held at Toronto. We have in the course of the past year referred to many of these papers in our pages.

Bibliography of North American Geology for 1914. This is Bulletin 617 of the United States Geological Survey, and has been prepared by John M. Nickles. The articles are given under the authors' names, and a cross index of subjects gives reference to the authors' names and pages.

Phosphate Deposits of Florida. By George Charlton Matson. United States Geological Survey, Bulletin 604. Literature on phosphates is scarce nowadays, as many of the standard books are out of print. This new description of the Florida deposits will therefore be welcome.

The Far-Eastern Mines of the Witwatersrand. Edited by A. N. Jackman, with map by A. J. Clevely. Price 1s. net. Published by *The Financial Times*. A convenient pamphlet giving details of the various mines in the Far East Rand and their equipment, with notes on the dividends and financial resources. The map is useful and up-to-date, but it ought to have been extended southward to include Heidelberg. For nowadays it is recognized that the Nigel group of mines contains the southern outcrop of the banket beds of the Far East Rand, and boring has been done at many points over the whole of the basin.

YEARLY REPORTS OF MINING COMPANIES

South Crofty.—This company was formed in 1906 by Messrs. Allen and Meyerstein, a London group of financiers, to acquire the tin-wolfram-arsenic mine of this name in Cornwall, situated between Dolcoath, East Pool, and Tincroft. The mine had been worked for many years previously on the cost-book system, but funds were exhausted and operations suspended. The London group provided the requisite capital for additional development and for the erection of modern dressing plant. We described the dressing plant, as improved by Josiah Paull, the present manager, in our issue of June 1913. Dividends have been paid regularly since 1909, in spite of the low grade and complexity of the ore. The report for the year 1915 shows that 70,790 tons of ore was treated for a yield of 627 tons of tin concentrate, 97 tons of wolfram, and 660 tons of arsenic. The revenue was £82,861, or 23s. 4d. per ton of ore. The cost at the mine was £75,442 or 20s. 11d. London expenditure, income tax, and depreciation added to the cost to the extent of £7149, or 2s. per ton. The balance brought in from the previous year made it possible to pay £5000 as dividend, being at the rate of 10%. During the year 3530 ft. of development work was done, only 460 ft. less than the previous year, a good result considering the scarcity of labour caused by the war. The grade of the ore disclosed was slightly better than during the previous two or three years. The most important work has been the further sinking of the shaft at New Cook's and the driving on the 205 to 260-fm. levels inclusive toward this section.

Grenville United Mines.—This company was formed in 1906, under limited liability law, to acquire a tin mine south of Camborne, Cornwall, that had for many years previously been worked on the cost-book system. The mine is very wet, and the pumping charges are high. Good profits were made at first, but the tin content of the ore began to decrease three years ago, and no dividend has been distributed since 1913. The report for the half-year ended December 31 shows that 23,088 tons of ore was raised and treated, and that the production of tin concentrate was 296 tons, being a yield of 28·8 lb. per ton. During the previous half-year, the yield per ton was 30·5 lb. from about the same amount of ore. The income from the sale of concentrate was £26,230, and other items brought the total revenue to £27,432. The working cost was £32,127, and the lord's royalty £70, so that the loss for the year was £4765. Fortescue's shaft has been sunk to the 395-fm. level, and a drift will shortly be commenced toward the expected downward continuation of ore-shoots that have proved profitable above.

Broken Hill Proprietary.—This company has for many years worked a silver-lead-zinc property in the central part of the Barrier Range, New South Wales, and has distributed £10,874,301 as dividends. Two years ago the development of the Iron Knob iron property, South Australia, was commenced, and the erection of blast-furnaces and steel mills at Newcastle, New South Wales. The lead and zinc smelting works at Port Pirie was sold to the Broken Hill Associated Smelters Limited a year ago, the latter company being owned conjointly by the Proprietary, North and South companies, and the Zinc Corporation. The cash received, £300,000, by the Proprietary on completion of this deal has been applied on constructional work at the iron and steel works. The report for the half-year ended November 30 last shows that 114,579 tons of ore was raised, being about 70% of the normal, the output being regulated by the requirements of the Associated Smelters. At the lead concentrator 98,798 tons of ore was treated, and 17,255 tons of concentrate was produced, assaying 60·6% lead and 28·39 oz. silver per ton. In addition 82,401 tons of dump tailing was re-ground and concentrated for a yield of concentrate averaging 52·6% lead and 28·15 oz. silver. The flotation plant treated 141,104 tons of zinc tailing, and produced 36,667 tons of zinc concentrate averaging 46·17% zinc, 6·56% lead, and 13 oz. silver. A plant for the production of zinc and lead concentrates from slime is being erected, having a capacity of 2500 tons per week. Some of the zinc concentrate is smelted by the Associated Smelters, and some is sold to America. No additional contract for the export of zinc concentrate has been made during the half-year. As regards the iron business, 99,289 tons of iron ore was despatched from Iron Knob to Newcastle during the half-year. The output of steel ingots was 37,311. The number of open-hearth steel furnaces is being increased from three to seven. The accounts show receipts from the sale of lead and zinc ore and concentrates £558,689, and from the sale of iron steel products £241,403. The net profit, after allowance for depreciation, taxes, and debenture interest and sinking fund, was £282,970, and £118,100 was paid as dividend, being 25% for the half-year.

Arizona Copper.—This company was formed in Edinburgh in 1884 to acquire copper mines at Clifton, Arizona. Three years ago the scale of operations was enlarged, and an entirely new smelting plant was built. The report now issued covers the year ended September 30. During the first three months of this period the production was reduced to 1200 short tons per month, the normal rate being 1800 tons, owing to the low prices ruling after the declaration of war. On September 11, 1915, the mine and smelter were closed on account of the strike, and work was not resumed until January of this year. During the year under review, 964,673 tons of ore was raised, of which 24,654 tons was sent direct to the smelter and 940,019 tons to the concentrating plant. The largest producer was the Humboldt mine with 534,388 tons; 181,978 tons came from the Clay mine, and 170,964 tons from the Coronado. The production was equivalent to 37,330,000 lb. or 18,665 short tons of bessemer copper. Of this, 2978 tons was electrolytically refined so as to obtain advantage of the higher price. The yield of copper per ton of ore was 39·23 lb., an increase of 3·06 lb. as compared with the previous year. In terms of percentage, this extraction is equivalent to 1·72%. The accounts for the year show an income of £1,208,048 from the sale of copper, and a profit of £578,017. Out of this profit, £57,770 was paid as debenture interest, £113,317 was allocated to the redemption of debentures, £70,000 was carried to reserve account for capital expenditure, £24,531 was paid as preference dividend, and £170,988 was paid as ordinary dividend, being at the rate of 45%. Owing to the difficulties caused by the strike, it has been deemed best to carry a large balance, £140,000, forward to the current year.

New Chuquitambo Gold Mines. — This company was formed in 1901 with a capital of £400,000 to acquire a group of gold-mining properties at La Quinua, in the district of Cerro de Pasco, Peru. The promoters were the Nimrod Syndicate, of which Lord Ernest Hamilton, Colonel W. H. MacGeorge, F. C. D. Haggard, and Frederick Löwy were directors. The company was drastically reconstructed in 1907, and the capital reduced to £25,000. Additional capital was raised in 1909 and 1911, and the capital now stands at £44,800. Small dividends on the reduced capital were paid for the years ended June 30, 1908, 1909, 1910, 1913, 1914, and 1915. Two years ago Merricks, Crane & Co., who had been for some time the consulting engineers, resigned, as did also several of the board. Since then Mr. Löwy has been chairman. The report for the year ended June 30 last shows that 19,556 tons of ore was treated, for a yield of gold worth £12,998. The profit was £2200, and £2240 has been distributed as dividend. The developments continue to expose supplies of ore, and machinery is on order for exploration at deeper levels. The cyanide plant, which was not a success at first, is to be re-started.

Oroville Dredging.—This company was formed in London in 1909 to acquire a majority of the shares of an American company which controls certain gold-dredging operations in the Feather river district, California. A few months later a property was acquired at Pato, Colombia, and a separate English company was formed to work it, the necessary capital being advanced out of the American Oroville company's profits. In 1914 additional land adjoining the Pato was acquired, and a company called the Nechi Mines (Colombia), Ltd., was formed to work it. The report of the American Oroville company now issued covers the year ended July 31 last. The properties are rapidly becoming exhausted. Two dredges were at work, and both of them were nearing the end of their efficiency. The total gravel treated during the year was 2,569,643 yds., and the gold recovered was worth $228,594, being 8·89 cents per yard. The working cost was $114,291 or 4·45 cents per yard. Interest on money lent to the Pato company amounted to $87,415. The sum of $20,000 was allowed for depreciation of dredges. Other small items appear in the accounts, after allowance for which a net profit for the year was left of $171,006. Adding the balance brought forward, the total surplus was $819,283, out of which $348,968 was distributed as dividend, being at the rate of 10%. The English Oroville company received £68,754 as dividend from the American company, and the profit on the flotation of the Nechi company was £5564. The net profit for the year was £72,664, out of which £49,720 was paid as dividend, being at the rate of 7½%, and £12,812 was placed to reserve against excess profits tax. During the year 33,516 shares were issued in exchange for an equal number of shares in the American company.

Lena Goldfields.—This company was formed in 1908 by F. W. Baker and the Consolidated Goldfields of South Africa for the purpose of purchasing a majority of the shares in the Lenskoie company, a Russian organization working rich gold gravels in the Bodaibo and other valleys adjacent to the Vitim river, a tributary of the Lena river in Eastern Siberia. The function of the Lena company has been to provide working capital for the Lenskoie, and during the last year or so to pass suggestions for improved methods of working from the company's engineer, C. W. Purington, to the board of the Lenskoie. The issued capital is £1,158,297, and at the date of the last balance sheet the holding in Lenskoie shares, about 60% of the total, was valued at £1,397,692. On the same date the cash capital lodged at Petrograd was £613,871, being used for financing the Lenskoie. The report of the Lena company for the year ended September 30 last shows credits of £50,071 received from dividends on Lenskoie shares for the year 1913-14, and £23,247 from interest. After administrative expenses had been paid, a balance of £62,714 remained. Owing to the difficulties of Russian exchange, no money has been remitted here and this balance corresponds to a Russian credit of 863,839 roubles. As a large number of Lena shares are held in Russia, it has been deemed advisable to declare the dividend in roubles, the rate per share being 1¼ roubles; with exchange at 13·77 to the £, this represents about 1s. 9d. Since the close of the year further holdings in the Lenskoie have been sold, and the funds thereby received will be available for financing the Lenskoie. During the year 1913-14, for which the Lenskoie dividend was paid, the output of gold was worth £1,384,450. During the year 1914-15 the output was £1,791,604, obtained from washing 974,234 cubic yards. Tributers' work brought the total output to £1,966,388. The yield per yard at the company's mines averaged 39s., but the biggest producer, Feodosievsky, gave a yield of 64s. 6d. per yard, gold worth £1,120,934 being extracted from 347,240 yards. The working cost for the past year has not yet been published by the Lenskoie, but Mr. Purington takes the cost per yard at 26s. 8d. The total reserves are estimated at 2,238,850 cu. yd., averaging 33s. 8d., with a gross gold content of 3¾ million pounds. At the Feodosievsky, the reserve is 957,300 yd., averaging 40s. 5d., and containing gold worth nearly 2 million pounds. We have already referred to Mr. Purington's recommendations relating to better methods of mining and gold-saving. An excellent article on the 'Gold Mines of the Lena,' by Mr. Purington, appeared in our issue for June 1915.

Brakpan Mines. — This company was formed in 1903 to acquire gold-mining rights on part of the farm Brakpan in the Far East Rand belonging to the Transvaal Coal Trust Company. A large share interest is held by the Consolidated Mines Selection Company. Milling was started in 1911, and the first dividend was paid for the year 1912. The report for the year 1915 shows that 821,525 tons of ore was raised, and after the rejection of 11% waste, 725,568 tons averaging 6·87 dwt. was sent to the mill. The yield of gold by amalgamation was 146,264 oz. and by cyaniding 94,063 oz., making a total of 240,327 oz. worth £1,011,555, being an extraction of 6·63 dwt. or 27s. 10d. per ton milled. The working cost was £653,160 or 18s. per ton, leaving a working profit of £358,395 or 9s. 10d. per ton. Extra charges of £11,375 were incurred in connection with the realization of the gold, owing to war conditions, and £48,015 was paid as taxes. The shareholders received £300,000, the distribution being at the rate of 40%. The tonnage and assay-value of the ore developed during the year showed a substantial improvement over previous years. Of banket developed, 49% was classed as profitable, and assayed 22·7 dwt. over 32 in. The total reserve was calculated on December 31 at 3,017,000 tons averaging 7·86 dwt. over 62 in., being increases of 527,000 tons and 1·13 dwt. as compared with the figures a year ago. The working cost was reduced by 6d. per ton, the yield was 3d. per ton higher, and the tonnage milled was 103,600 more than in 1914. The total yield was £152,440 greater, and the profit £74,940 greater, and the dividend was 40% as compared with 32½%.

Springs Mines.—This company was formed in 1909 to acquire gold-mining rights on property in the Far East Rand belonging to the Transvaal Coal Trust Company. The management is in the same hands as the Brakpan. Two vertical 7-compartment shafts have been sunk 4500 ft. apart, and the lode was intersected at depths of 3557 ft. and 3846 ft. in March and August 1913 respectively. The report for the year records that, additional funds having been raised by the issue of £314,950 debentures, development in the South Shaft section was increased and in the North Shaft section resumed. The footage sampled in the two sections was 10,670 ft., of which 52% was classed as profitable, averaging 27·8 dwt. over 23·7 inches. The total ore reserve at December 31 was estimated at 1,125,000 tons, averaging 10·4 dwt. over a stoping width of 57 in. This shows an increase during the year of 572,000 tons. A metallurgical plant with a monthly capacity of 30,000 tons has been ordered, and construction work was commenced in June. Provided no undue delay is experienced in delivery, the plant should be running towards the close of the present year.

Randfontein Central.—This company is under the control of Sir Joseph B. Robinson, and was formed in 1911 as an amalgamation of the Central and South Randfontein companies. The mines are in the far west Rand. The report for the year 1915 shows that 2,466,520 tons of ore was milled, for an extraction of 345,489 oz. gold by amalgamation and 335,226 oz. by cyanide, a total of 680,715 oz. or 5·52 dwt. per ton. An average of 905 stamps ran during the year, distributed over 5 separate mills. The amount of development done was 135,921 ft. The ore reserve on December 31 was estimated at 4,449,324 tons averaging 7·4 dwt. In addition, 3,285,153 tons averaging from 4 to 5·3 dwt. is classed as unprofitable at present working costs, and 3,306,859 tons averaging 2·8 dwt. is also mentioned. The income from the sale of gold was £2,857,877 or 23s. 2d. per ton. The working profit was £655,788, out of which the following items were deducted: Debenture interest £171,648, redemption of debentures £86,400, taxes £70,131, contribution under Miners' Phthisis Act £48,901, other expenses £57,446, allocation to shaft-sinking, development, and equipment £170,319, and dividend £108,592, being at the rate of 2½%. To be set against this dividend was the issue of £150,000 new shares to the parent company, Randfontein Estates, for the purpose of bearing the extra cost of development, etc., over the amount above mentioned charged to revenue account. Owing to the adverse conditions due to the war, it has been decided to close down three of the smaller stamp-mills and to send the ore to the more modern Central mill.

Langlaagte Estate & Gold Mining.—This company was formed by J. B. Robinson in 1889 to work an outcrop property in the central Rand, and for some years the mine was a leading producer. In 1909, as the property was approaching exhaustion, the adjoining properties belonging to the Block B and the Langlaagte Exploration companies were absorbed. The report for the year 1915 shows that 612,297 tons of ore was milled, and that 85,957 oz. gold was extracted by amalgamation and 81,642 oz. by cyanide, a total of 167,599 oz., or 5·47 dwt. per ton milled. The income from the sale of gold was £700,905, or 22s. 10d. per ton, and the working profit was £164,736, or 5s. 4d. per ton. The shareholders received £132,975, being at the rate of 15%. The ore reserve stands at 1,161,119 tons averaging 6·08 dwt., an increase in tonnage of 274,723 and in assay-value of 0·11 dwt. Small amounts of ore are still being obtained from the original Langlaagte mine, but the future of the company lies with Block B.

Cordoba Copper.—This company was formed by John Taylor & Sons in 1908 as a consolidation of the Cerro Muriano and North Cerro Muriano companies, operating copper mines in the south of Spain, 10 miles northeast of the city of Cordoba. Dividends were paid in 1912 and 1913. During the last two or three years, the copper content has declined, and during 1915 the output of blister copper was 1767 tons obtained from 89,639 tons of ore, as compared with 1941 tons from 87,870 tons in 1914, and 3500 tons from 119,069 tons in 1913. The report for 1915 shows an income of £132,302, and working expenses £122,226. Out of the balance, £4564 was allocated to income tax, and £6000 was written off the coal mine account. In addition £6000 was spent on capital account on new plant and at the coal mine. Development during the first part of the year was disappointing, but later better results were obtained, so that the outlook is more hopeful. The ore reserve was estimated at the end of the year at 134,289 tons averaging 2·64% copper, as compared with 155,270 tons averaging 2·87% the year before, and 206,489 tons averaging 3% at the end of 1913. The ore treatment is not simple, and consists of hand picking, wet concentration, concentration by the Murex magnetic process, sintering, and briquetting. The products are treated in the blast-furnace, and the matte bessemerized. During the year, the Murex plant treated 11,070 tons of middling and slime averaging 1·42% copper, for a yield of 1137 tons of concentrate averaging 9·45% copper, the tailing averaging 0·43%.

Barramia Mining & Exploration.—This company was formed in 1909 by John Taylor & Sons, as a subsidiary of the Egypt and Sudan Mining Syndicate, to acquire the Barrahme gold mine situated between Edfu, near Assuan, on the Nile, and the Red Sea. The veins are narrow, and occasionally very rich pockets of gold are found. The report for the year 1915 shows that 5870 tons of ore was raised, and that gold to the value of £15,230 was extracted. These figures compare with 5200 tons and £17,724 the year before. A characteristic rich discovery gave gold worth £4000 from about half a ton of ore. The working cost during the year was £11,150, royalty £306, and allowance for depreciation, income tax, etc., £988. The preference shares received £2025, being at the rate of 7½%. These shares are entitled to a non-cumulative dividend at the rate of 10%, a rate that has been maintained since the start until the past year. The only dividend paid on the £28,000 ordinary capital was 4% in 1912. The superintendent, F. J. Tregay, reports that no important discoveries of ore have been made, but that at several points the indications are favourable to the extension of the stoping areas. The reserve is estimated at 8500 tons, as compared with 12,000 tons the year before. Of the reserve, 3500 tons averages only 3 dwt. per ton. Developments have been continued on the Semna mine 96 miles to the north, and 8000 tons of ore has been disclosed. To test the ore 100 tons has been sent 22 miles to the stamps of the Atallah company as a bulk sample.

Sudan Gold Field.—This company was formed in 1904 by John Taylor & Sons to acquire prospecting licences in the Egyptian Sudan between the 20th and 22nd parallels of latitude. Eventually operations were centred on the Om Nabardi gold mine, which is about 300 miles south of the property of the Barramia company mentioned in the preceding paragraph. Additional capital was raised in 1908 and the first dividend was paid in 1914. The report for the year 1915 shows that 17,125 tons of ore was milled, for a yield of 12,335 oz. of bullion by amalgamation, and 19,385 tons of tailing was treated by cyanide, for a yield of 1928 oz. of bullion, the total gold being worth £49,041. The working cost was £29,998, and £7599 was allowed for depreciation and capital expenditure. The shareholders received £6387, the dividend being at the rate of 10%. The output and the profit were much the same as in the previous year. The yield per ton of ore was rather less, but the deficiency was made up by the treatment of accumulated tailing. Toward the end of the current year, the old tailing will be exhausted. It has not been possible to proceed with the plant for the treatment of accumulated slime, of which there is 15,000 tons, but it is hoped to start on its erection shortly. The ore reserve has been increased during the year from 54,055 tons to 61,530 tons, in spite of the restriction of development owing to shortage of explosives. There is also a large reserve of lower-grade ore, and the directors propose to double the capacity of the plant by the addition of 10 more stamps.

Mysore Gold.—This company was formed in 1880 to acquire old workings in the Kolar district, Mysore state, Southern India, and dividends were first paid in 1886. Since then, gold worth £17,060,568 has been extracted from 4,525,871 tons of ore, and £8,100,594 has been distributed as dividends. John Taylor & Sons have been continuously in control of operations. During the last five years, the average content of the ore mined has shown a decrease; and the yield per ton for 1915 was 57s. as compared with 80s. in 1910. The total gold output has been maintained by increasing the tonnage treated. The report for 1915 shows that 305,000 tons of ore was milled, and 173,065 oz. of bullion obtained, and 54,618 oz. of bullion was extracted from sand and slime. The total output was 207,981 oz. fine, of a realized value of £880,167. The working cost was £363,882, income tax £27,744, allowance for depreciation £17,807, and expenditure on capital account, chiefly for shaft-sinking and new plant, £80,406. The dividends absorbed £335,500, being at the rate of 110%, as compared with 115% for 1914 and 125% for 1913 and 1912. Less development was done during 1915, the total being 22,238 ft. as compared with 26,249 ft. in 1914, owing chiefly to the irregularity in the delivery of explosives, but also to irregularities in the supply of hydro-electric power from the Government power station at the Cauvery falls. The ore reserve was nevertheless maintained, standing at 1,044,000 tons as against 1,014,000 tons at the end of 1914. R. H. P. Bullen, the superintendent, reports that developments in depth have been mostly in low-grade ore, but that more recently rather better results have been obtained. He foreshadows a possible decline in the yield per ton during the current year. A new ore-shoot has been found at the 3226-ft. level in McTaggart's section, at the southern end of the mine, that promises to yield ore of higher grade than the present average of the mine. The developments also in Ribblesdale's section have disclosed comparatively rich ore.

Nundydroog.—This company belongs to the Kolar group of gold mines in Mysore State, India, operated under the management of John Taylor & Sons. Dividends were first paid in 1888. The total production of gold to the end of 1915 has been £5,901,247, obtained from 1,710,504 tons of ore, and £2,200,868 has been distributed in dividends. The report for the year 1915 shows that 94,000 tons of ore was raised and treated, yielding 70,219 oz. of bullion, and that 88,479 tons of sand tailing and 104,182 tons of slime were treated for a yield of 14,940 oz. of bullion. The value of the total gold extracted was £321,650. During the previous year, gold worth £303,340 was extracted from 89,950 tons of ore and 95,633 tons of sand tailing. The slime plant was started at the beginning of the year, and as the total yield of gold was thereby increased, ore of slightly lower grade was sent to the stamps. The working cost was £159,702, royalty £18,052, income tax £8033, and expenditure on plant and shaft sinking £38,693. The shareholders received £99,050, the dividend being at the rate of 35%, the same as for 1914 and 1913. C. H. Richards, the superintendent, states that the development has been largely successful, and that between the 2300 and 2750-ft. levels stoping operations have revealed enlargements and plications of the lode. The three chief shafts, Oriental, Kennedy's, and Taylor's, are now at the same depth, 3500 ft., and ventilation has been greatly improved. In the deepest part of the mine, below the 3500-ft. level in Kennedy's section, a winze is in ore averaging 27 dwt. over 46 in. The ore reserve is estimated at 210,500 tons, as compared with 164,800 tons a year ago.

Ooregum Gold.—This company operates one of the gold mines of the John Taylor & Sons group in the Kolar district, Mysore State, India, and is on the same lode as the Mysore, Nundydroog, and Champion Reef. Mining was commenced in 1888, and dividends have been paid continuously since 1891. The report for the year 1915 shows 153,266 tons of ore was milled for a yield of 70,548 oz., and 178,206 tons of tailing treated by cyanide for a yield of 16,098 oz., making a total yield of 86,646 oz. worth £365,970. The working cost was £189,798, royalty £21,290, income tax £6906, written off for outlay on plant, etc. £26,565, and allocation to reserve and other funds £5500. The dividends distributed totalled £120,231, the rate of the preference dividend being 40% and of the ordinary 30%. These rates were slightly less than those for 1914 and 1915. The tonnage and yield for the three years showed little variation, but the costs were increased owing to various causes, chiefly the higher charges for transport of material by sea, the increased price for supplies, and the advance in the charges for electric power obtained from the Cauvery Falls. The results of development have been excellent, and the reserve has been increased by 101,365 tons during the year, standing on December 31 at 367,625 tons. This increase, following on an increase of 79,313 tons for 1914 over 1913, is particularly gratifying, seeing that the workings are at a greater depth than those at the other Kolar mines. For some time it has been anticipated that a new shaft would be required for continuing adequate development at depth. The position of the shaft has been fixed at a point 688 ft. from the southern boundary, and its depth is estimated at 4086 ft. It will be circular in section and brick-lined. During the year, the re-grinding plant has been started, and modifications have been made in cyanide treatment. After the tailing is re-ground in the new tube-mills, it is passed over amalgamating plates before being sent to sand and slime classifiers.

Balaghat Gold. — This company belongs to the group operating in the Kolar district of Mysore State, Southern India, under the control of John Taylor & Sons. The mine is the most northerly of the five producers on the lode, and has been the least successful. Work was started in 1886, but three reconstructions were necessary during the next ten years. From 1900 to 1907 good results were obtained, and dividends amounting to £227,800 were distributed, though in the meantime additional capital amounting altogether to £117,000 was raised by the issue on two occasions of preference shares and on one occasion of ordinary shares. During the last seven years the mill has been worked at a two-thirds capacity owing to the amount of available ore of profitable content being restricted. The report for the year 1915 shows that 36,684 tons of ore was raised, yielding 14,455 oz. of bullion by amalgamation; 96,252 tons of tailing, current and accumulated, was treated by cyanide for a yield of 3323 oz. of bullion. The total output of bullion was 17,778 oz., worth £67,984. These figures were not much different from those of the previous five years. The working cost was £63,990, and the allowance for depreciation was £3709. A debit balance of £16,645 was brought forward from the previous year, and after the adjustment of several small items, the year ended with an adverse balance of £17,782. A slime plant with a capacity of 2000 tons per month has been erected. The ore reserve at the end of 1915 was estimated at 26,133 tons, as compared with 23,887 tons at the end of 1914. In addition, the reserve of sand and slime tailing was computed at 56,793 tons. During the year, 4509 ft. of development work was done. At the 3425-ft. level, the deepest part of the mine, 49 ft. of the lode assays 34 dwt. over 18 inches. In the adjoining Nundydroog mine, the developments at depth on the 'Old Oriental' shoot have been of a promising nature, and as this shoot should enter the Balaghat ground at the 3175-ft. level, an additional hopeful feature is provided for exploration at depth.

Jibutil (Anantapur) Gold Mines.—This company is a subsidiary of the Anantapur Gold Field, operating in Madras Presidency, India, and it was floated in 1911. John Taylor & Sons are the managers, and W. Stonor is superintendent. Additional capital was subscribed in 1912 and 1913, and it was intended to raise further funds last year for the purpose of expanding the scale of development, but war conditions have rendered this step inadvisable for the time being. Milling commenced in September 1914 with 10 stamps and a cyanide plant. The report now issued, covering the year ended September 1915, shows that 29,590 tons of ore, averaging 7¼ dwt., was milled, and that 5298 oz. was extracted by amalgamation and 3738 oz. by cyanide, a total of 9036 oz. worth £38,285. The working cost was £38,525. Development has been restricted to the funds available from revenue. The reserve stood at 36,500 tons on September 30. The deepest point of the mine, at 1000 ft. on the main ore-shoot, is responding more satisfactorily to development than did the two or three levels above, but the grade of the ore so far exposed is low, being from 5 to 7 dwt. over 5 to 6 feet. Mr. Stonor considers that the general outlook has improved. The continuity of the lode has been established, and indications are favourable to a rise in the grade of the ore as greater depth is attained. He expects to be able to maintain the gold returns during the current year, a slight fall in the grade being balanced by a higher tonnage.

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

EDGAR RICKARD, *Managing Director*. H. FOSTER BAIN, *Editor*. EDWARD WALKER, *Assistant Editor*

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CONTENTS.

REVIEW OF MINING

Introductory. — The outstanding feature of the month has been the great advance in the price of silver. This rise cannot be said to have been unexpected, though few anticipated its rapidity and substantial character. An advance from 27d. to 37d. per ounce in two months is the biggest movement for years, and though the rise has not been fully maintained, the price is now on a level with that which ruled twenty or more years ago, before the stoppage of silver purchases under the Sherman law in America and the adoption of a gold reserve in India. Silver mining companies are favourably affected, and Cobalt mines expect to make up for the fall in the local output. The rise in price is largely due to the big purchases for currency purposes in this country and in France. The fall of production in Mexico accounts to some extent for the present shortage of supplies, and the threatened prohibition of silver exports from that country causes much uneasiness. Another reason for shortage follows on the fact that the Government wants all the silver-free lead it can get for munition purposes, and that in consequence silver-lead bullion and ores are not in demand. The rise in the price of copper has also been a notable feature of the month. Electrolytic has gone to over £155, and standard to £140. The Government restrictions against speculation have caused the amount of business on the Metal Exchange to be limited, and the daily official prices have been based on comparatively small transactions. The Government purchases of copper in the United States are enormous, contracts covering 120,000 tons having, it is said, been arranged within the last month.

Transvaal.—The output of gold on the Rand during April was 728,399 oz., and in outside districts 26,273 oz., making a total production of 754,672 oz., worth £3,205,643, as compared with 768,714 oz., 27,975 oz., 796,689 oz., and £3,384,121 during March. The number of natives employed on the gold mines at the end of April was 199,936, as compared with 203,575 at the end of March, and 186,941 a year ago. The number of natives employed on the diamond mines at the end of April was 938, as compared with 13,656 before the war.

Our Johannesburg correspondent reviews the position in the Far East Rand, and expresses the opinion that the Government's terms will have to be modified before capital is attracted for development on any adequate scale. The report by the Government Mining Engineer, Mr. R. N. Kotze, which was issued on May 6, confirms this view. Mr. Kotze considers the sliding scale fixing the Government's share in the profits as unsatisfactory, and he strongly recommends an alteration in the method of leasing State mines.

The flood of yearly reports in the South African market makes it impossible to make more than brief mention of important features at individual mines. As regards the Rand Mines group we may note that the Robinson is in its last year of production, and that the stopes in the Leader and South Reef are exhausted. At Modderfontein B the development of the western section has progressed far enough for the engineers to form the opinion that the whole of that part of the property contains ore of good grade; on the other hand the ground to the south and east of the central hoisting shaft is disappointing. The results at Crown Mines are discussed elsewhere. City Deep shows an increase in the ore milled from 505,300 tons to 677,200 tons as compared with 1914, but the metallurgical plant is still working at considerably less than full capacity. In the list of holdings by Rand Mines Limited we note 15,000 Gedulds and 5000 Modder Deeps.

The Van Ryn Deep has been developed by two incline shafts from the foot of vertical shafts near the Kleinfontein boundary, these inclines following the dip of the reef. Their inclination has recently been made steeper than the dip, the angles being changed from 14° to 30° and 35° respectively. By this arrangement much less shaft-sinking will have to be done, and the ore in the lower levels will be developed by a system of main haulages and cross-cuts. The expenditure will thereby be decreased substantially. It is noteworthy also that, with the exception of cleaning-out the development ends, all work is now done on the day shift.

The Consolidated Langlaagte is one of the Barnato mines that has responded well to the expenditure on development and modern plant during the last few years, after a long history of indifferent results. The outlook has been recently clouded by comparatively poor results obtained by development at depth in the new section below the dike, both on the Main Reef Leader and the South Reef.

At the Government Gold Mining Areas, also under Barnato management, where milling commenced in October 1914, the grade of the ore milled and of the reserve has consistently improved. The yield per ton advanced from 20s. 5d. in January 1915 to 26s. 10d. in December, and the reserve was increased during the same period from 2,450,000 tons averaging 5·8 dwt., to 3,665,000 tons averaging 6·9 dwt. The improvement in the position of this great property since the commencement of milling is particularly gratifying, for at the start many people considered that the assets consisted more of hopes than of assurance of success.

The Transvaal Coal Trust Company is to change its name to the Rand Selection Corporation, and to make an agreement with the Consolidated Mines Selection Company whereby the latter agrees to advance working capital to a maximum of £300,000 in return for an option to purchase 100,000 shares at 65s. each. The Corporation is to be entitled to participate to the extent of 25% in any new ventures introduced by the Consolidated Mines Selection. The Transvaal Coal Trust Company was originally formed to acquire mining rights in the Far East Rand on the Brakpan and Springs farms, and in early days the coal deposits at shallow depth were worked. Of recent years the deeper gold deposits have been the important assets, and these have been developed largely by money provided by the Consolidated Mines Selection Company, which acts as secretary to the Trust. The elimination of the word 'coal' from the name of the company removes a cause of bewilderment to recent arrivals in the share market.

The Messina company has declared its first dividend, being at the rate of 20%, and absorbing £36,357. This is on account of the year ending June 30 next. During the first nine months of the year, the output of concentrate was 8720 tons averaging 42% copper, and 1101 tons of matte averaging 56% copper. The high price of the metal is greatly in the company's favour, but some trouble is caused by the scarcity of white labour owing to enlistments for both Europe and German East Africa.

The Zaaiplaats Tin Mining Co. announces that it has acquired from the Transvaal Consolidated Land Co. a base-metal lease of 120 claims adjoining the company's property. By this means the life of the mine will be substantially increased. The purchase price was £10,000 in cash and £3750 in shares.

Rhodesia. — The output of gold during March was reported at £335,368, as compared with £313,769 in February, and £299,686 in March 1915. We note that the Lonely Reef produced £14,748 from 5290 tons, as compared with £13,247 from 4730 tons in February, and £11,458 from 4020 tons in January. The other mineral returns for March included 35,388 tons of coal, 6300 tons of chrome ore, and 288 tons of copper.

The lawsuit between the Amalgamated Properties of Rhodesia and the Globe & Phœnix lasted 84 days before the taking of evidence was concluded. On resuming the hearing after the Easter vacation, counsel commenced their addresses. Each leader is expected to speak for a week at least, and no doubt Mr. Justice Eve will take some time in preparing his considered judgment. So the end is not yet within measurable distance. The financial statement of the Globe & Phœnix company in the report for 1915 shows that £48,678 had been spent on the litigation by December 31, and an additional £72,000 out of the profits has been earmarked for further expenditure in this connection.

The Cam & Motor company reports the discovery of a rich leader on the 7th level. The published assays are high, in one case a borehole being reported to have produced a core 15 in. long averaging £350 gold per ton. Further details relative to the extent of this new deposit are awaited.

West Africa.—The output of gold during March was worth £150,987, as compared with £137,739 in February and £153,770 in March 1915. The yield at the Abbontiakoon was £4585 higher than in February, and the Prestea Block A, Taquah, and Abosso mines also showed an increase.

Nigeria.—The briskness in the tin market has helped to maintain the interest in Nigerian tin company's operations. Another fillip was given by the Anglo-Continental Mines returning to the list of dividend payers. At the meeting of shareholders, Mr. Oliver Wethered announced that coal is now being mined at Udi, and that the Nigerian railways are already using it. It is confidently expected that before long the coal will be available for the tinfields, at a price of 30s. per ton. The fuel question has always been troublesome, for coal has had to be imported from England, and wood is not available in great quantities. It will be remembered that it is scarcity of fuel that has caused oil engines to be tried.

The Mongu is one of the Anglo-Continental Mines group that has done well. Formed at the beginning of 1914 to acquire property in the Ropp district, it soon established itself on a dividend-paying basis. During the year 1915 the output was 490 tons, won by calabashing. The present monthly output averages 55 tons. The directors are not contemplating the adoption of any other method of mining at present.

Australasia.—Development at depth at the Broken Hill South mine is disclosing ore of much lower grade than the average. During the latter half of 1915, the small amount of ore raised from the 1270 ft. level, 1570 tons, averaged only 9·8% lead, 9·6% zinc, and 3·2 oz. silver per ton, as compared with 14·6% lead, 14·8% zinc, and 7·5 oz. silver, the average of the 163,494 tons raised during the period. The ore reserve was estimated at 3,350,000 tons, sufficient to last for eight to ten years.

Broken Hill Block 10 has joined the Associated Smelters, and made a contract for the treatment of its output of lead-silver concentrate. Work at the mine was accordingly recommenced on May 10.

The Melbourne *Argus* gives figures relating to the distribution of Broken Hill Proprietary shares. In February this year it was ascertained that 782,454 shares were on the London register, 177,149 shares on the Adelaide register, 171,374 at Melbourne, 40,007 at Sydney, 4495 at Broken Hill, 3418 at Port Pirie, and 2109 at Hobart. Fewer by 40,000 are on the London register than two years ago. These appear to have been transferred to Melbourne holders.

Mr. W. M. Hughes, Prime Minister of Australia, stated in a recent interview that he was hopeful of reaching a satisfactory agreement with British metal dealers and manufacturers whereby the whole of Britain's spelter requirements will be produced in this country. However, whatever arrangements are made must have the sanction of the Imperial Government, which has already shown definite evidence of failure to grasp the necessity for generous support.

The Edna May group of gold mines at Westonia, West Australia, has been one of the brightest spots in Australian gold mining recently. As we have several times recorded, the owners of adjoining leases cannot agree to an amalgamation, and the development and mining work is unnecessarily duplicated. The Edna May Central has just had a stroke of good luck, for in the course of cross-cutting on the 75 ft. level a new lode has been discovered. It has since then been proved by a cross-cut from the 150 ft. level. So far it has been followed for 180 ft., and averages 2 oz. per ton over 10 ft. Cross-cutting is now in hand on the 250 ft. level.

The decline of Charters Towers as a gold mining centre proceeds apace. The yield during 1915 was worth £241,625, as compared with £265,948 in 1914 and £297,259 in 1913.

The Great Fitzroy gold-copper mine at Mount Chalmers, Queensland, will probably be re-opened by means of funds supplied by the State Government. The Minister of Mines recently visited the property and it is believed that he has reported favourably, provided that local people also subscribe some part of the funds. This mine has been a disappointment to English investors, but with copper at a high price and with improved flotation plant, better results may now be obtained. It is stated also that the Government is to acquire the Mount

Molloy copper smelting plant in North Queensland.

A 12th level is to be opened at the Waihi at a depth of 1447 ft. The station is already cut, and 48 ft. driven. On the 11th level no further ore has been found in the Martha and Empire lodes, but large blocks have been developed in the Royal and Edward lodes. On the 7th, 8th, 9th and 10th levels the Royal lode is still yielding new supplies of ore. The reserve has been fully maintained, and the results of mining and treatment, as described elsewhere in this issue, are much the same as in the two previous years. As compared with the last of the highly prosperous years, 1909, the tonnage treated is now about one-half, and the yield per ton two-thirds.

India.—The main shaft of the Hutti (Nizam's) mine is down to 2922 ft. and a level is being driven south at 2800 ft. The ore so far disclosed on this drift is variable in value, in one case the assay being as high as 11 dwt. Judging by experience in upper levels, the quality of the ore should improve as driving continues. The ore of highest grade was found at the 1940 ft. level. The north shaft has been sunk to 2069 ft., and will be continued to the 2660 ft. workings in order to improve the ventilation at depth. During 1915 the yield was £68,414 from 29,550 tons of ore, and £6957 was paid as dividend, being at the rate of 10%. The efficiency of the cyanide plant has been greatly improved recently.

The recent developments at Balaghat were described at the meeting of shareholders by Mr. Henry Taylor, and the general impression is that the indications are favourable in more than one direction. In particular, the exploration southward toward the Nundydroog is expected to tap the continuation of rich ore that is now being worked in that mine.

Canada. — The report of the Canadian Mining Corporation for the year 1915 is so complete in every detail that it should satisfy the most inquisitive shareholder and put an end to statements that the directors desire to withhold important information. The irregular character of the Cobalt silver deposits affords little opportunity for a forecast of future earnings, and the consulting engineer finds it impossible to estimate the life of the property. The geology of the mines has been thoroughly studied, and with sixteen miles of underground workings and numerous bore-holes, ample opportunity has been afforded for arriving at definite conclusions concerning the nature of the deposit and for proving definite boundaries within which silver ore is likely to be found. That more high-grade ore will be opened-up in this restricted area is certain, but as to quantity or total yield no one ventures an opinion. At the end of the year less than one year's production is accounted for as reserve, but the position in this respect is the same as last year, and with the better knowledge of the district we look for lower development costs. The following figures taken from the yearly report are interesting:

	Oz.
Silver production 1915	4,563,957
Estimated reserve, December 1914	4,009,440
Produced in excess of reserve	554,517
Estimated reserve, December 1915	3,937,995
Developed during year	4,492,512

The average price realized for silver sold during 1915 was 52·53 cents per ounce. With a production of 4,500,000 ounces, which can be reasonably assumed for 1916, each one penny increase in the price of silver will give £18,000 additional profit. Even the most sanguine cannot hope for any great life for the Cobalt properties, and the directors, having examined and turned down no less than 124 properties in Canada and the United States, are wise to turn to Russia as a field of greater possibilities. The company has assembled an excellent technical staff and it would seem opportune to press their investigations of new fields with all diligence while the organization is still intact.

United States. — The operations at the Ducktown smelter, owned by an English company, are curtailed during the summer, owing to the decree of the Supreme Court restricting the total discharge of sulphur during the season to 20 tons, the decree being the result of litigation by neighbouring farmers. The amount of ore treated during 1915 was in consequence lower than the year before by 18,600 tons, the figures being 150,400 tons and 169,000 tons respectively. The copper and sulphuric acid produced were lower, the figures being 2685 and 2931 tons, and 41,295 and 45,770 tons. The company reports a continuous increase in the ore reserve at the Mary mine, the amount now standing at a million tons averaging over 2% copper and 17% sulphur.

The figures relating to zinc in the United States during the year 1915 show that 158,852 tons of zinc ore was imported as compared with only 31,962 tons during 1914. This increase indicates the amount of concentrate brought from Australia. Not one-third of this material had been actually smelted at the end of December, for the production of zinc from Australian ore during 1915 was returned at 10,235 tons. The total output of zinc in the United States during the year was 489,519 tons, as compared with 353,049 tons, an advance which reflects the tremendous demand for munitions. Of this total 458,135 tons was obtained from domestic supplies of ore, 13,943 tons from Mexican ores, and 5103 tons from Canadian ores.

A final decision has been made to erect the lead smelting plant of the Bunker Hill & Sullivan at the mine, Kellogg, Idaho, instead of on the Pacific Coast, as the conditions as regards freight, fuel, and fluxes favour local smelting. The ore and concentrate is at present treated by the American Smelting & Refining Co. at East Helena, and at Selby, on San Francisco Bay. The latter company has now lost two of its big clients in the Cœur d'Alene, the Hercules also having recently withdrawn custom.

The Utah Copper Co. announces its intention of building a leaching plant to treat the oxidized copper capping that is now being removed from the sulphide orebodies. The capacity is to be from 2000 to 3000 tons per day. The other American copper companies that have adopted leaching on a large scale are the Anaconda and the Calumet & Arizona, the latter having erected a plant at the New Cornelia, at Ajo, Arizona.

Mexico.—Conditions in Mexico are not improving. The recent demand for the shares of certain Mexican mining companies was due to the spectacular rise in silver. The disturbances in Mexico, and consequently the curtailment of silver production, have contributed largely to the enhanced value of the metal. Mexico in normal times is credited with 35% of the world's production of silver. No optimistic views should be entertained of any early resumption of peaceful conditions in this important Republic. Mexicans have proved beyond any manner of doubt their complete incapacity for either settling their own difficulties or maintaining a peaceful government. The only hope for restoration of prosperity will come from military intervention by the United States. But even should the government at Washington be willing to intervene, they are woefully unprepared to carry out the necessary military programme.

China.—The Minister of Commerce, Chow Tze-chi, having become convinced that the mining laws promulgated a year or so ago are unworkable and unattractive to foreign capital, has decided to evolve a new set, and has commissioned Mr. G. G. S. Lindsey to make suggestions. Mr. Lindsey is a lawyer who has held the presidency of the Canadian Mining Institute, and is eminently qualified for the duty. He will have the assistance of Mr. A. S. Wheler, who is known to our readers as an authority on Chinese mining conditions and resources. Mr. Lindsey has for many months been in China in connection with negotiations for certain mining rights in the province of Sze-chuan, acting as legal adviser to a British financial group composed of the Central Mining and Investment Corporation, the British & Chinese Corporation, and S. Pearson & Sons.

Notable Deaths.—We refer to the death of J. H. Collins in our editorial columns.—We have lost another West Country engineer by the death of Thomas Richards, who like his father Isaac Richards, and his son Charles H. Richards, had served the firm of John Taylor & Sons for many years. In earlier days he spent twenty years in Chile, where he was in charge of copper mining operations, and later he was in charge of railway construction and copper mining in Venezuela. More recently he was for a long time manager of the Nundydroog gold mine in Mysore, and in addition acted as consulting engineer to his firm. One of his last examinations was in connection with the Ouro Preto mine in Brazil, when he advised an expansion in the scale of operations.

EDITORIAL

OUR thanks are due to a host of friends in South Africa for their kind reception of our editor, Mr. H. Foster Bain, and for their overwhelming offers of facilities for studying mining and metallurgical practice on the Rand and elsewhere in the Transvaal, and also in Rhodesia and the Congo. If he accepted every invitation, the haunts of London Wall would not see him again for over a year. But so prolonged an absence would never do. We have already received some interesting notes of his impressions relating to labour on the Rand, which will appear in our next issue, and during the next few months, after his return, our readers may expect many informing articles and lively comments.

EVERYONE connected with mining will be distressed to hear that Mr. R. T. Bayliss was a victim of one of the Zeppelin raids over the Eastern Counties last month. A flying fragment from a bomb injured him so severely that it has been found necessary to amputate his left arm. At the time of writing he is reported to be going on well. Our readers will join with us in a message of sympathy to the invalid.

WE take pleasure in publishing in this issue a description of the Ashanti gold mines, written by the consulting engineer, Mr. W. R. Feldtmann. This group of mines presents many features of interest. The soft hanging wall made it necessary to exercise care in the choice of a method of mining, and the graphitic content of the schist gave ample scope for metallurgical ingenuity. Then the discovery by lateral exploration of a rich shoot of ore, which proved to be a continuation of an orebody that had been comparatively poor in the upper levels, provides concurrently an argument in favour of lateral exploration and an example of enrichment in depth. Moreover the shoot had the grace to pitch toward the main shaft from which the cross-cut had been driven, instead of showing the usual perversity of things by pitching away from it.

EXCELLENT advice to young writers is given in a recent circular of the United States Bureau of Mines, in which the editor remarks as to the making of bibliographies: "Don't make a bibliography lengthy to impress the public with your erudition. Readers may wish the bibliography were half as long, with one-tenth the number of mistakes."

EACH spring we are deluged with reports of mining companies covering the results of the previous calendar year. Another period of similar congestion is in December when reports are issued by companies that make it a practice to hold the shareholders' meeting at as late a date in the year as the law allows. It is a pity that these 'peak-loads' are allowed to occur, for neither the public nor the newspapers have time to read the many reports carefully, and so pick out the interesting and significant points. Cannot the mining houses agree to some plan whereby their wares shall receive greater attention? We have always felt that the New Modderfontein venture, the first of the deep-level mines of the Far East Rand, acquired no small part of its effective advertisement from the fact that its annual statement is issued at a time of year when investors have more leisure to devote to the study of individual reports.

A DETERMINED soul with a monkey wrench can do much, and the proverbial ability of a woman with a hairpin may be put to shame by a workman who has skill and initiative. Buying tools is easy, or was until the munition makers swept the market; but the ability to accomplish results regardless of the tools available is without price. Many a well-trained technical man lacks that power to work with what he must. We have heard of a graduate geologist who sat by the office stove for three weeks, because he had to order from a distant city a particular kind of iron nail for his boots before attempting to climb the mountains. We may add that that particular geologist geologizes no longer for the equally particular mine manager who told us the story. One of the most successful master-mechanics we ever saw at a mine was a man who had been trained as a marine engineer. He had a most uncanny ability to effect repairs with few tools and when conditions seemed all against the prevention of a long shut-down. The finicky geologist mentioned can hardly be fairly taken as representative of the tribe, for geological engineering is based upon balancing probabilities and working through approximations. The geologist deals with so many variables that minor differences in measurement often fall within his limit of error. He has his reward when he finds, as has happened, a trained engineer puzzling over a plane-table because he cannot set it up over a tree and so occupy the exact station indicated. There is need for moderation in all things and, while we would not—at least within the hearing of any budding mining engineer—decry refinement and accuracy, we do venture to emphasize the value of the spirit and a certain rough skill that enable some men to market their knowledge better than others. We were asked recently to find for friends operating many miles away, "a good mill-man, one who does not require a whole machine shop before he can work," and it set us thinking.

MEMBERS of the Royal School of Mines Association dined together on Thursday, May 4. Mr. S. J. Speak presided. The absence of conventional evening dress went a long way to make the event informal, as it was intended. We imagine, from the success of this and other gatherings of a similar nature, that the oppressive formalities which accompanied dinners of this kind in pre-war times will be abandoned for good. Sir Alfred Keogh stated that no less than 361 past and present students and 13 of the teaching staff were on active service. The detailed accounts of individual acts of bravery given by Sir Alfred from the official records, and by Lieutenant Guy Taylor, himself fresh from participation in the fighting in France, created a lasting impression of the magnitude of the service that School of Mines men are rendering to their country. We have already expressed our views in previous issues on the value of military training to the mining engineer. We know now how equally useful a mining engineer's training is to the military. It is a far cry from London to California, and there is a decided difference between the turmoil of warfare and the peaceful pursuits of a community so far removed from the scene of conflict, but nevertheless it was fitting that along with the tales of deeds of bravery in the trenches should come the cabled news of the appointment of Frank Holman Probert to the chair of Mining at the University of California. Probert became an Associate of the School of Mines in 1897, and has since attained success chiefly on the North American continent. The School of Mines at Berkeley has always held a high position among the many American mining schools. The chair of mining was made vacant at the end of 1914 by the death of Professor Samuel B. Christy, and a committee of prominent and successful engineers has been actively searching for a suitable successor. We are pleased that this honour should have fallen to an Associate of the Royal School of Mines. It is one more evidence that the interests of the two countries are cemented together, at least in a united profession. Members of the Association abroad will be glad to know the organization is thriving, and every old student should give his hearty support by at least enrolling his name as a member.

Engineering and Management.

Mining engineers come more and more to concern themselves with problems of finance and management. The old days when a man could be expected to know, and in rare instances could really know, the details of all branches of engineering connected with mining have passed away, never to return. Now the engineer must, against a general background of training in science, and with as much practical experience underground and in the mill as a kindly fortune may allot to him, build his career on those problems of management, of buying, and of selling that are common to most businesses. For technical details the mining engineer must depend upon his professional brethren in electrical, mechanical, railway, and other branches of engineering, and it is a mistake not to recognize this frankly. If there were a freer interchange of information, and a more general custom of inter-consultations among engineers practising in various branches of the profession, it would make for better results. We have elsewhere written of the availability of the 'handy man' and the desirability of young mining engineers learning to dominate their tools rather than resting content to be dominated by them. We would not be understood by this to minimize the importance of special knowledge. There is no real contradiction. In a sense the chemist, the geologist, the electrical engineer, and the mechanical engineer, are all tools of the mining engineer, and this is at the same time what the chemists call a 'reversible reaction.' Confining attention to our own subjects, we may conceive the mining engineer as defining and stating the problem in a given case, and his associates working out the solution. The essential thing is that the most expert knowledge available is utilized in each case, and that the mistake is not made of over estimating the accuracy of one's own knowledge.

Curiously enough managers are willing to tolerate, which about describes their attitude in too many instances, a mechanical engineer or other specialist above ground when they would not think of asking his advice as to matters below. We have already expressed the opinion that it would be a good thing for the mines and also for mechanical engineers if the latter were occasionally taken below ground. Both would profit, and the benefit would not be only pecuniary. Too many poor mechanical devices are left to struggle alone in the dark, and many an underground railway needs at least occasional expert attention from an experienced traffic manager. We have known many double-track cross-cuts and even long tunnels to be driven where a single track would accommodate all the traffic that could ever be sent to it, and other mistakes of like nature. Mining engineers need always to keep in view the fact that their structures are short lived, even temporary in character. In that their work is more like that of a contractor than of the civil engineer, who delights in, and is fortunately warranted in building, permanent structures where final economy is the chief consideration. We fear, however, that too much is sacrificed in many cases to the supposed temporary character of mining work. Mines do occasionally outlive their owners, and many mines outlive their plants. Many ore deposits are sufficiently large to justify much better engineering than is expended on them. The larger mining groups recognize this, and employ specialists in many lines to advise with their operating staffs. The smaller companies might well arrange for consulting services more widely than is customary.

The Manganese Position.

Manganese is one of the metals that have been disturbed by the war. The British consumer has not been inconvenienced to any great extent, but the Russian producers have lost their export trade, owing to Germany and Austria being cut off as enemies, and to the closing of the Dardanelles which prevents delivery to friendly and neutral nations. Germany has had to revert to the use of lower-grade ore mined within her own borders. The United States has never been self-supporting in this particular and has imported both ore and ferro-manganese. Consequently steel-makers in that country who have no supply under their own control are badly hit and are sometimes tightly squeezed. The present occasion is opportune for a short review of the uses and production of manganese.

Manganese is a metal closely allied to iron, and its chief use is in connection with the metallurgy or constitution of iron. Many of the ores of manganese and iron are of a similar nature and appearance, and they often occur together, in varying proportions. The first use of a manganese ore was in glass-making, where dioxide is added for the purpose of removing the green colour caused by the presence of iron, the added oxide serving to change the iron compound from the ferrous to the ferric state with the result that the bright green colour is altered to a pale and almost invisible yellow. About a hundred years ago the dioxide ore was applied, at Tennant's chemical works, Glasgow, for the production of chlorine from hydrochloric acid. This process is still employed by alkali makers as a subsidiary to the Leblanc soda manufacture, though nowadays chlorine is chiefly made electrolytically. The actual amount of dioxide consumed in chlorine manufacture is restricted by the fact that nearly all of it is recovered and can be used over again. The value of manganese in steel manufacture was discovered eighty years ago by Heath, who found that manganese dioxide and carbonaceous matter if added to wrought iron of poor quality produced a steel of excellent grade. Hitherto it had only been possible to produce high-grade steel from pure Swedish or Russian iron. Heath's invention made it possible to use British iron ores, thereby greatly reducing the price of best steel. In the fifties, Mushet completed the Bessemer invention by using an iron-manganese alloy containing carbon for restoring to the bessemerized iron the desired proportion of carbon. Bessemer's process consisted in refining pig iron by oxidizing the impurities by means of an air blast. But the result of this action was to produce a pure wrought iron free from carbon, for it was impossible to judge when to stop the blast at the moment when the carbon content had been reduced to the desired amount. In Mushet's reaction the manganese acted as a carrier for the carbon, which could not be incorporated in the wrought iron if added by itself. The virtue of Heath's discovery lay in the facts that a small proportion of manganese strengthens steel, counteracting the adverse effects of impurities such as sulphur and phosphorus, and that it also reduces iron oxide formed in the operation. In the days of the development of the Bessemer process, the manganese-iron alloy was obtained from Germany, where pig iron containing 10% manganese and 5% carbon was produced under the name of spiegeleisen. It was found, however, that this class of alloy was not desirable, for if so much was added as to introduce the right amount of manganese into the steel, too much carbon was introduced at the same time. An alloy higher in manganese was then sought, and eventually ferro-manganese was produced, containing as much as 80% of the metal. Both spiegeleisen and ferro-manganese are made in the blast-furnace, in much the same way as pig iron, but ferro-manganese requires a greater heat than is customary. Ferro-manganese can also be produced in the electric furnace.

It will be seen from the above remarks that manganese used in small quantities has played an important part in the general development of the steel industry; but this is not all, for it has been found that the presence of manganese in comparatively large proportions imparts special properties to steel. Such alloys are of exceptional hardness, and moreover are not magnetizable. Thus they are admirably adapted, in the one case, for the construction of wearing parts such as the jaws of ore-breakers and the points and crossings of railways and tramways, and, in the other, for the construction of those parts of electrical machinery that should be non-magnetic. Both of these series of alloys were discovered and developed by our friend Sir Robert Hadfield.

Of other uses of manganese and its ores, we may mention the alloy with copper known as manganese bronze, which combines strength with resistance to the attack of salt water. The dioxide is one of the elements in the Leclanché dry battery. The manganates and permanganates of soda and potash are valuable disinfectants. Various compounds are employed in the manufacture of pigments. The characteristic of manganese compounds, especially the dioxide, namely, the ease with which part of the oxygen is released, accounts for many of the chemical applications.

The manganese ores of commerce are all oxides, hydrated oxides, or mixtures of these with iron and other oxides. The silicate, rhodonite, and the carbonate, rhodocrosite, are well known to miners, but their economic value is negligible. The purest ore is pyrolusite, known to chemists as dioxide, peroxide, or black oxide. Psilomelane is dioxide more or less hydrated and containing potash and barium oxides. Braunite is sesquioxide associated with silica. Manganite is hydrated sesquioxide. Franklinite, a compound oxide of iron, manganese, and zinc, is found in New

Jersey, and after treatment for zinc is utilized for the manganese content. Wad, or bog manganese, is an earthy mineral of uncertain composition, generally containing much iron. Manganese and iron oxides are found associated with silver, and after the extraction of the precious metal are occasionally used as raw material for the manufacture of iron-manganese alloys. The purer qualities of manganese ores, notably pyrolusite, are in demand for chemical applications, but for the purposes of the steel manufacturer, the manganese ores containing iron, found in large quantities in several parts of the world, are chiefly in demand. The relative manganese and iron contents vary widely, so that different names are required for the various grades. Ore averaging 45% manganese or over is properly called manganese ore; that containing 25 to 45% may be called ferruginous manganese ore; that containing 5 to 25% is suitably called manganiferous iron ore; while less than 5% manganese receives no recognition in the nomenclature or in the terms of sale, though some of it finds its way into the pig and steel. The manganese ores originally used by English steel makers came from Wales and the West of England, but afterward the spiegeleisen was imported from Germany, as already noted. In early days in America, spiegeleisen was made from franklinite, and from manganese ores and manganiferous iron ores that are found in various parts of the United States and Canada. These deposits, however, have not hitherto been of any great importance, and the only survivor is the franklinite enterprise. Supplies of ore were afterward obtained from Chile and Cuba. The great expansion in the use of manganese arrived on the discovery of vast deposits of high-grade ore in the Russian Caucasus, at the back of Batoum, about thirty-five years ago. The ore has been shipped extensively to England, France, Belgium, Germany, and America. Afterward came the development of the deposits in the state of Minas Geraes, Brazil, and in Bengal, Madras, and the Central Provinces of India. The Brazilian resources are great, but as is the case with the iron ores of the same district, the distance from the coast and the lack of shipping facilities have militated against their development on a large scale. During the last complete year before the war, the Caucasus headed the output with about 1,100,000 tons, and was followed by India with 750,000 tons. The exports from Brazil fell during the three years before the war, but since then the demand from the United States has caused a strong revival, and during 1915, 350,000 tons was exported. The greater part of the Brazilian ores have gone to the United States; for the Indian ores, Great Britain was the best customer, followed by Belgium, France, and the United States; of Caucasus ores, Germany was the biggest buyer, then Great Britain, Belgium, and the United States. The United States had to supplement its production of ferro-manganese from imported ores by purchasing approximately an equal amount of ferro-manganese from Europe, 90% of which came from Great Britain. The altered conditions have caused the steelmakers of the United States to rely more on Brazilian ore and to develop some of their neglected home resources. These figures explain the position created by the war, as outlined in our opening sentences.

The Big Rand Producers.

The excellent prospects and the activities in connection with the Far East Rand are apt to withdraw public attention from the mines in other parts of the Rand, and it is well, therefore, to hark back occasionally to some of the older ventures, which a few years ago occupied a similar position as regards the limelight. We accordingly take this opportunity of reviewing the present position of the three largest individual producers: The Crown Mines, controlled by the Rand Mines, Ltd., the Randfontein Central, controlled by Sir J. B. Robinson, and the East Rand Proprietary, of the Farrar group. During the year 1915 the figures for the yield of gold at these three properties were £3,164,343, £2,846,488, and £2,495,086 respectively, figures which indicate the gigantic scale of operations. All three are consolidations of groups of properties that had previously been worked separately, and the policy of amalgamation was adopted for the purpose of reducing working costs and so bringing within the payable limit large tracts of ground that otherwise could not be worked at a profit. Unfortunately the reduction in costs has not proved as great as expected, and the luck of mining, in the way of striking rich ore, has been against the companies. Consequently the dividends have not come up to expectations, and the shares now stand at much lower figures than at the time of the consolidations. It must be admitted also that the future of the ore reserves as regards content is causing anxiety, especially at the East Rand Proprietary. But if the mines are not meeting the primary requirement of investors, they are at any rate doing their duty to the Empire by providing large yields of gold and so expanding our credit and our cash resources, and for the time being shareholders will have to console themselves with this reflection.

	Crown Mines	East Rand Proprietary	Randfontein Central
Share capital	£940,106	£2,445,897	£4,343,700
Debentures	£829,200	£1,151,240	£2,832,000
Par value of share	10s.	£1	£1
Quotation of shares at time of formation of Company	£9 10s. (1909)	£5. 15s. (1908)	55s. (1911)
Quotation April 1916	£2. 15s.	15s.	11s.
Ore reserve, December 31, 1915 tons	9,938,000	4,800,000	4,449,324
Ore reserve, dwt.	6·25	6·3	7·4
Stamps	660	820	905
Tube-mills, average	26	25	not stated
Number of separate milling plants	4	4	5
RESULTS FOR THE YEAR 1915.			
Ore raised, tons	2,816,431	2,127,026	2,585,191
Ore milled, tons	2,497,000	1,983,600	2,466,520
Yield of gold, oz.	763,061	602,967	680,715
Value	£3,164,343	£2,495,086	£2,846,488
Yield per ton	25s. 4d.	25s. 2d.	23s. 2d.
Working cost	£2,017,791	£1,894,094	£2,202,089
,, per ton	16s. 2d.	19s. 1d.	17s. 11d.
Working profit	£1,146,552	£600,991	£644,399
,, per ton	9s. 2d.	6s. 1d.	5s. 3d.
Capital expenditure	£98,099	£103,091	£170,319*
Debenture interest	£43,288	£58,585	£171,648
Redemption of debentures	£85,750	£108,760	£86,400
Government taxes	£179,563	£83,765	£70,131
Other taxes and charges	—	—	£57,447
Miners' phthisis contribution	£22,455	£19,399	£48,901
Dividends	£611,068	£275,163	£108,592
,, rate per cent	65	11¼	2½

* During the year £150,000 capital was raised to provide for capital expenditure in addition to these figures. If these funds had not been provided, it would not have been possible to distribute a dividend.

In the accompanying table we arrange the results of the three properties during 1915 in parallel columns, and we give additional figures relating to the capital, debenture debt, metallurgical plant, and market quotations of the shares. It will be seen that the best results were obtained by the Crown Mines. The figures for the yield per ton at the Crown Mines and East Rand Proprietary were much the same, but the cost per ton at the latter was 3s. higher, which made a great deal of difference in the total working profits and the dividends declared. The relative figures for the nominal capital of these two properties give the dividend results at the Crown Mines a better appearance. The Randfontein Central results are the least satisfactory of all. The share capital and debenture issue are both far greater than those of the other two properties, and the charges for debenture interest and the expenditure on capital account out of revenue are high. When all expenses were met, no balance out of a working profit of £644,399 was left for the distribution of dividends, and a dividend was only made possible by raising £150,000 by the issue of new shares and thus meeting part of the capital expenditure. The assay-value of the reserve, 7·4 dwt., is much higher than the yield per ton during 1915, 23s. 2d., a discrepancy explained by the fact that on December 31 all ore assaying less than 5·3 dwt. per ton was eliminated from the estimate of reserve.

The Crown Mines was formed in 1909 to amalgamate several companies and other interests. Of the mines acquired, the Crown Reef on the outcrop was nearly exhausted. The Crown Deep and Robinson Central Deep still contained much ore of excellent grade. Other mines on the west had not been successful as separate ventures, as the proved blocks contained ore below the payable limit, and an extensive tract of still deeper ground had not been tested to any great extent. The devisers of the plan of consolidation counted on the average ore over the whole property being sufficient to yield an excellent profit under a reorganized system of underground operations which was estimated would substantially reduce the costs. The older and more prosperous companies entering the consolidation had reserve funds that were applied for the purposes of development and reorganization, and an additional million pounds was raised by the issue of debentures. In those days the 10s. share was quoted at £9. 10s., and dividends of 130% were expected when the work of reorganization was complete. These hopes have not been fulfilled, for no rich ore has been found to replace that in the Crown Reef and Robinson Central Deep, and the yield per ton has gradually fallen from 34s. to 25s. 4d. The grade of the ore might have been maintained for two or three years if the plan to absorb the Robinson outcrop mine had been adopted, but the Robinson shareholders were unwilling to sanction the proposal. For one reason and another the working cost has been 3s. higher than estimated. The dividends have sunk from 110% to 85% and now to 65%, and the current quotation of the shares is 55s. At the present time only 50% of the ore developed in the lower levels is above the payable limit, and the average of this payable ore is not given. The development of the ground to the south of the great dike is now in hand, and judging by results at neighbouring mines, there is no reason why a profitable mine should not be brought into existence. These developments will of course make a further drain on the profits of the company. To sum up, we may remark that if the Crown Mines is regarded as a large low-grade property, and its past history forgotten, the general position may be considered satisfactory. It is when the unduly rosy promises of seven years ago are remembered that the results have the disappointing look.

The East Rand Proprietary was expanded to its present form in 1908 for the purpose of re-absorbing a number of companies that had some years before been floated to work adjoining mines, of which the Driefontein, Angelo, Comet, and Cason were the most important. It was expected that the consolidation would decrease the working costs to such an extent as to warrant the expectation of 40% dividends. It was soon found impossible to maintain the yield per ton at the level calculated. Three years ago the drop in the yield was alarming, and after much inquiry it was found that in order to keep the stamps to capacity and thus secure a low working cost per ton, the manager had not been able to exercise the usual care in selecting the ore. Since then the results of further development can only be described as bad. The ore reserve is only sufficient for two years. At the Cason two of the drifts are in profitable ore; at the Hercules only two out of eleven drifts have been consistently in profitable ore; at Driefontein the ground is much disturbed and the water troubles make development extremely difficult; the Angelo and Comet sections are already fully developed, so no more ore can be obtained in those areas. There is a possibility that south of the water dike the Driefontein may contain further supplies of ore, but development of this ground will not be easy from either the financial or engineering standpoint.

The history and recent position of the Randfontein Central are not as clearly set forth in the company's publications as shareholders and the public would wish. Sir Joseph B. Robinson has always adopted an independent policy, and has been out of harmony not only with his shareholders and his own managers but with the other Rand groups. The company is the final of three different consolidations in 1907, 1909, and 1911, on the last named occasion the whole of the Robinson mines in the far west Rand coming under one management. The results obtained have been uniformly disappointing, and the working profits have mostly gone back into the mine for development purposes. The yield per ton was 23s. 2d. last year. The announcement has been made that three of the mills are to be closed. For the reasons mentioned in our explanation of the tabular statement, ore of a higher average grade is to be mined, but the total amount of ore handled is not expected to be reduced, for the modern central plant with its tube-mills is considered to be equal to the demands that will be placed on it. Little or no information is available whereby to judge of the future prospects of this company.

It is not suitable on this occasion to examine closely the reasons for the decline in the assay-value or yield per ton and the inability of the engineers to reduce the costs to the extent expected. But for the benefit of readers in other countries familiar with much lower costs per ton as the results of amalgamation and mining on a large scale, we may say that on the Rand the most profitable ore is usually measured in inches of thickness. The orebody is not 60 ft. wide as at Alaska Treadwell, and it does not cover a mountain side as at Utah Copper. Thus the amalgamation of a number of adjacent mines has not to any extent altered the system of mining, and each section is still largely worked as a separate unit and its ore treated at its individual mill. Other conditions such as are connected with labour, cost of supplies, and government regulations and requirements are not of the same relative importance in their general influence on costs as is the nature of the orebody itself. How much the failure to attain the low costs prognosticated is due to these secondary influences, and how much to the inability of the engineers to devise as economical a system of underground work as they expected, is difficult to determine.

Joseph Henry Collins.

Cornwall lost its protagonist when J. H. Collins died in mid-April. No one knew the geology of the old county so well, and nobody believed so implicitly that Cornish mining still has a future. When he first knew Cornwall the tin-mining industry was at its zenith; then he saw its gradual decline to a position of less relative importance owing to the competition of Eastern and Australian producers; and he subsequently witnessed the struggles during recent years to keep the few remaining mines in operation. But in the evil days, as in the earlier prosperous days, his optimism for Cornish tin was never damped, and his prophetic vision for better days to come was never clouded. His enthusiasm for things Cornish was not confined to tin. Who does not remember his eloquent claims for Cornwall as the home of everything best in mining practice: the Cornish pump, the Cornish roll, Trevithick's locomotive, and last, but not the least important, the Cornish miner?

Mr. Collins was born in 1841. In his student days at Jermyn Street his rivals were Liversedge and Sollas. On the recommendation of Robert Hunt he was in 1868 appointed Lecturer and Assistant Secretary to the Miners' Association of Devon and Cornwall, succeeding in that position the late Sir Clement Le Neve Foster. During his residence in Truro he was also the secretary of the Royal Cornwall Polytechnic Society. From 1881 to 1884 he was chief chemist and metallurgist to the Rio Tinto Company, but as the hot climate of Southern Spain threatened to enfeeble his vitality he returned to England and established himself in London as a consulting engineer. Among the many services rendered to his profession may be mentioned the active part he took in founding the Mineralogical Society and the Institution of Mining and Metallurgy. His writings also have been of great help to students and engineers, and his *magnum opus*, 'Observations on the West of England Mining Region' will stand for ever as the record of Cornish geology and mines.

The principle underlying all his work is disclosed by his definition of the object of mining as the extraction of metals for the use of man; there was no mention of current profits or of the appreciation of capital values on the Stock Exchange. He never spared himself where duty called. Many a time he was to be seen, even in recent years, in the rain, wind, and chill of a Cornish winter (for the advertised Cornish 'Riviera' is only a myth), on the platform of a countryside junction, wet through, waiting patiently for the connecting train which never seemed to come. Many a younger man would have postponed his appointed visit to a mine on days of that sort.

Not only did Mr. Collins do well by his profession on his own account, but he raised four sons who have worthily upheld the honour and dignity of the position of mining engineer. Henry is known for his work in Spain and Mexico, and as the author of 'The Metallurgy of Lead'; Arthur was assassinated, while manager of the Smuggler Union mine at Telluride, owing to his resistance to the unjust claims of the miners' union; George is a consulting engineer in Denver; and Edgar is known as a successful manager, his latest position having been at the Commonwealth mine in Arizona.

It was appropriate that he should live to see the time when the fortunes of Cornwall are reviving, and when his old contention that exploration should be conducted laterally and at shallow depths is receiving the support of other geologists and managers and has been rewarded by such excellent results. He could feel that he had not lived in vain and that his cheery optimism had exercised a beneficent influence. So with his last breath he could say, with Simeon of old: "Now lettest thou thy servant depart in peace."

THE CENTRAL TREATMENT PLANT.

THE MINES OF THE ASHANTI GOLDFIELDS CORPORATION

By W. R. FELDTMANN.

An account of the most important gold mining enterprise in West Africa, with details of its history, the nature of the ore deposits, the method of mining, and the metallurgical process of extraction.

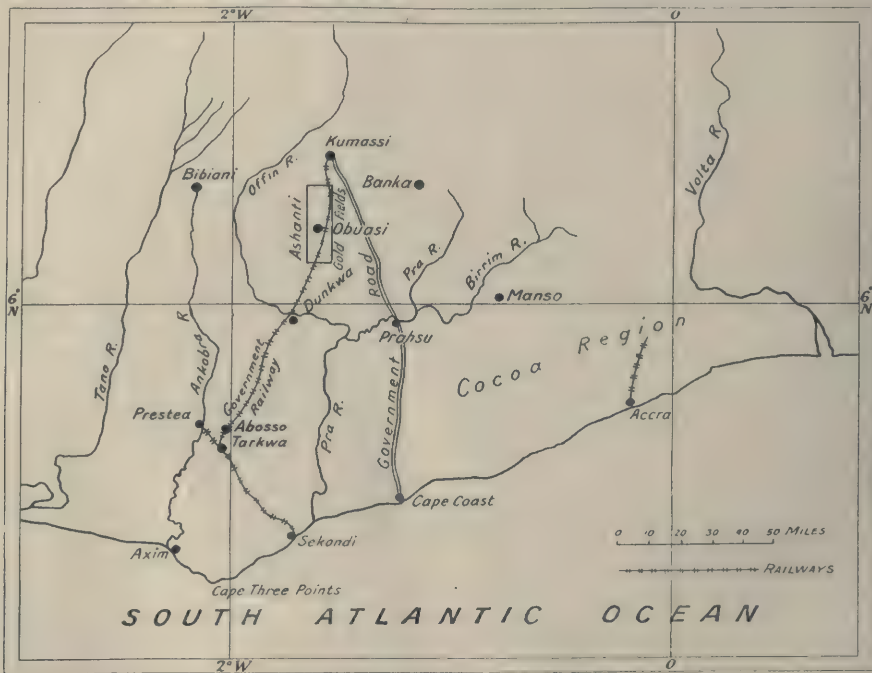
GOLD mining is an ancient industry in West Africa and its general history has been already given in the Magazine. So I shall proceed, without further introduction, to the particular history of the properties of the Ashanti Goldfields Corporation which form the subject of this article.

HISTORICAL.—As far back as 1890 a native trader, who knew the Ashanti country well, approached E. A. Cade, then a merchant connected with the Gold Coast trade, with the suggestion that the latter should interest himself in taking up some rich gold properties in Ashanti. It was not until 1895 that Cade took active steps in the matter. In that year he made an expedition from the coast into Ashanti and, having satisfied himself as to the representations made to him by the native intermediary, got into touch with the kings of Bekwai and Adansi, and obtained from them formal agreements for grants of territory, partly in Bekwai and partly in Adansi, the two grants forming one compact area of one hundred square miles, measuring 20 miles by 5 miles, in extent. When it is remembered that in 1895-96 the politics of Ashanti were very much in the melting pot, and that the sanctity of human life was, in the native mind, subordinate to a number of other considerations, we may be sure that Cade's expedition was attended with considerable personal risk. He believed, and so far he has certainly not been proved in error, that he had secured the best gold area in Ashanti. That he may have formed illusory impressions of the richness of his concessions is natural enough, for he was not versed in mining. That he did actually secure what is, so far as yet proved, the richest tract of country in Ashanti is, however, very remarkable, and it must probably be ascribed to his having had inside information from native sources such as not many white men have, or ever have had, at their disposal in West Africa.

Cade returned to London with his grants in his pocket, and in association with a few of his friends, constituting the Cote d'Or Syndicate, set about negotiating for the formation of a company to work the properties secured by him. Preliminaries were retarded by the fact that with the destoolment and deportation of King Prempi, in 1896, the Ashanti Protectorate was brought more directly under British control, and it was considered necessary to have the concessions from the native chiefs ratified by the British Government. After considerable delay the matter was regularized to the satisfaction of everyone concerned, so that in 1897 the Ashanti Goldfields Corporation was formed, and it acquired, under concession direct from the Government, mining, trading, and agricultural rights over the 100 square mile area above mentioned. The authorized capital of the corporation was £250,000 in £1 shares. Of these 50,000 were issued as fully paid to the vendors and 64,000 shares were issued at 7s. 6d. called up. The original members of the board were: Frederick Gordon (chairman), Viscount Duncannon (now the Earl of Bessborough), Edward H. Byas, George Edwards, and Edwin A. Cade (managing director), with C. W. Mann as secretary.

In the autumn of 1897 an expedition led by E. A. Cade, with John W. Daw as engineer and a staff numbering fifteen men, proceeded to the property to commence mining operations. They took with them 40 tons of machinery, including a 5-stamp mill, with tubular boilers and a sectionalized engine, saw-milling plant, etc., and arrived at Cape Coast Castle, then the most convenient port, on November 22 of that year.

It is doubtful whether any gold mining venture that has eventually won through to success has been burdened from the start with a greater load of adverse conditions. Ultimately, of course, the natural wealth of the property determined the measure of success attained, but an immense amount of strenuous effort on the part of the staff in West Africa and of tenacity and patience at the London end of the business contributed to it. When it is recalled that, in addition to the difficulties common to all countries of initiating a new enterprise requiring the organization of supplies and labour, etc., there were great drawbacks special to West Africa, it is possible to form some sort of an estimate of the obstacles that had to be surmounted. Some of these speedily became apparent to the pioneers. The transferring of machinery and stores from ships in an open roadstead, where, at the best of times, there is a heavy swell, into small surf-boats; the conveyance by these and the landing, sometimes through a big surf, on an open sandy beach; the transport on the heads of natives for over 100 miles of forest tracks; all these conditions not only entailed heavy cost of transport but necessitated the sectionalizing of machinery, so as to restrict the weight of any individual load to a maximum of 150 lb. With regard to sectionalized mining machinery it will suffice to say, generally, that it is only a few degrees better than no machinery at all.

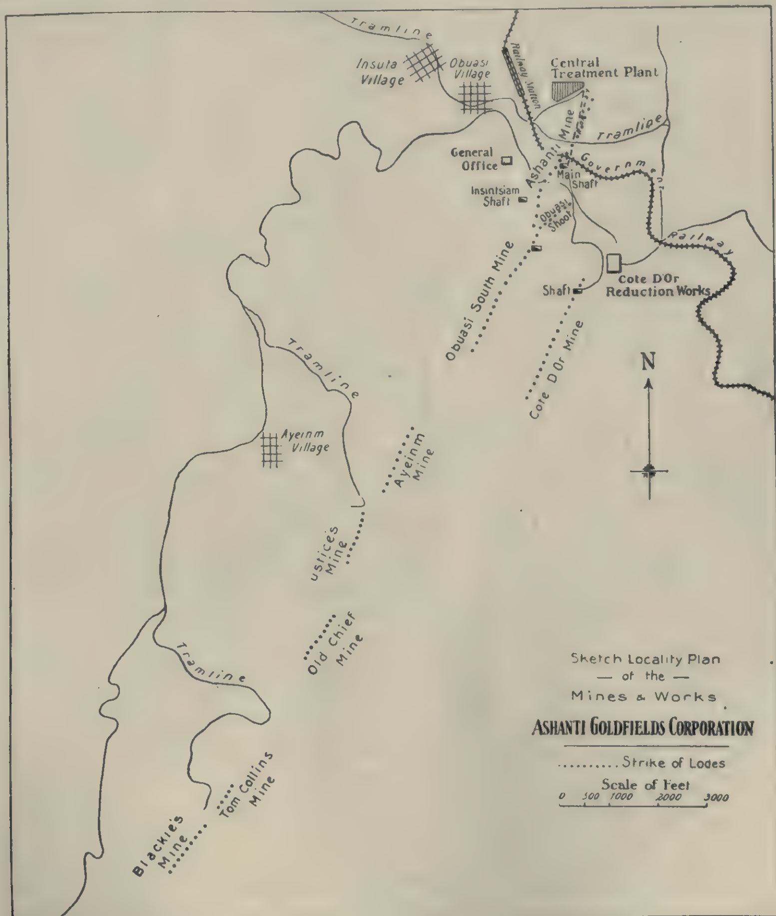


MAP SHOWING POSITION OF ASHANTI GOLDFIELDS PROPERTY.

The pioneers pitched camp on the property before the end of 1897. As a preliminary operation they had to have sufficient trees felled in the virgin forest to clear sites for dwellings and machinery, for though the natives in the neighbourhood must have dug for gold for many years the clearings in the jungle were few and insignificant in extent, being confined to the small villages and 'farms,' that is yam and plantain patches. The selection of sites was probably largely governed by the proximity to extensive native workings. Certainly the camp site, around which the Obuasi of today has grown up, could not have been better chosen in relation to the workings which at the present time are the most important ones. The pitch selected for the first stamp-mill was less happily chosen, but doubtless served its purpose for a start.

The difficulty of correlating and gauging the importance of the various gold occurrences which had been worked and were, in places, still being worked by the natives and of selecting the best spots for starting mining development was, in the circumstances, very great. The topography of the country in the neighbourhood of the native workings was, with the exception of the existence of the gold, about the only one of the natural features favourable to the immediate purposes of the corporation. The belt of country on which most of the work had, and since has, been done is hilly, and includes some fairly high ridges, spurs of the Moinsi Range. The normal valley level is about 700 ft. above the sea, and some of the hill-tops are as high as 1800 ft.

The native gold digger had, for many generations, been accustomed to sink pits through twenty, thirty, and forty feet of a barren clay or earth overburden to get at the gravel or rubbly subsoil in the valleys, and to gouge out the friable outcrop rock of the veins on the hill-tops and sides with the most primitive appliances. But he had never followed any of the orebodies by means of tunnels, to which the topography of the country is so well adapted. Partly, perhaps, because he would have been unable to break through hard bars of country which would be encountered, and partly because he could not have dealt with the harder ore found at fifty feet or so below the surface. Perhaps, also, it never occurred to him. Be this as it may, the ore indicated by outcrop workings and, owing to the hilly ground, easily accessible to adit workings formed the earliest and most rapidly available source of revenue to the corporation. Indeed, owing to the rapidity and relative ease with which such early



results were obtained, a much too optimistic view of the prospects of the corporation was taken. For it was natural to suppose that if the native in his primitive way of work had discovered a number of orebodies, there must be a considerably larger number which had not been revealed by his unskilled search. It was only later, when it was found what consummately good prospectors the old natives had proved themselves to be (or, what would lead to the same result, what an immense amount of prospecting they must have done), and when it was realized that the various scattered native workings represented, with one or two notable exceptions, all there was to find on the property, that a more correct perspective became possible. This inevitably led to a period of disillusionment. But these alternations of sentiment are too common in new gold mining districts to call for detailed mention in this case.

It does just seem worth while remarking, however, that adit mining, invaluable as it was to the corporation in enabling it to obtain results as rapidly as possible, tended to accumulate penalties against the day when the veins would have to be attacked below valley level; penalties, that is to say, in the way of work to be re-arranged, equipment to be removed, etc. This does not detract from the efforts of the early pioneers who were out to prove as quickly as possible that the property was a valuable one. In a very few months they had erected the 5-stamp mill and the saw-mill, and had got to work. By end of June 1898, they were able to report having crushed 262 tons of ore, chiefly from Ashanti, Obuasi, and Ayeinm, for a yield of gold worth £2665.

Undeterred by the difficulties and great expense of transport, the corporation rapidly added to its installation of machinery at the property, and the resulting increase in the output, indicating the growth of a new industry, was doubtless a potent argument in prevailing on the Government of the day to extend the railway from Taquah up into Ashanti. Nevertheless it was not until after the native rising in Ashanti, in the latter half of 1900, that this railway extension was seriously taken in hand, and it was not until 1903 that rail communication between Sekondi and Obuasi was established. It is interesting to note that during the time of the rising, when the greater part of Ashanti was in a turmoil and some severe fighting took place between the expeditionary force and the natives, no hostility was shown to the white staff of Obuasi. Indeed, the then deputy manager, H. L. Webster, and several of his staff remained unmolested at the mines throughout the campaign. Labour, of course, was upset and active operations suspended for several months, during which the workings suffered unavoidably from want of attention.

The arrival of the railway at Obuasi roughly synchronized with the start of a period of disillusionment, due to the approaching exhaustion of the most easily accessible ore, previously obtained from adit workings, and a realization that orebodies above valley level were neither so numerous and extensive nor, in some cases, of such high value as had at first been believed. Attention was then perforce directed more and more to deeper mining. With the improved transport facilities afforded by the railway, new and better machinery, including winding engines, headgears, etc., was provided. An excellent system of tram-lines, started in the early days to connect the various workings, was extended and perfected. Substantial buildings, workshops, stores, etc., were erected and, generally, the surface equipment began to take organized shape. But the backward state of development underground minimized, for several years, the benefits of the increasing efficiency in surface equipment.

Arduous efforts were made to increase the ore reserve so as to bring this into line with the capacity of the new and heavier stamps that were installed. These efforts met with a welcome reward in 1908, consisting in the discovery of an important ore deposit now known as Justice's mine. A few months later the rich Obuasi shoot was cut at No. 3 level of the Ashanti mine. Methods of treatment both for Justice's oxidized ore and for the deeper level ores from Ashanti mine were evolved and plants installed and, by 1910, the benefits of the new discoveries of ore and of the adaptation of treatment methods began to make themselves felt in an economic sense.

The payment of dividends, which had been commenced somewhat prematurely in 1900, was intermittent and, over the first twelve years of the existence of the corporation, relatively inconsiderable. It was not until 1910 that circumstances permitted the commencement of regular distribution of profits on a scale approaching, but probably still far short of, early anticipations. The following were the dividends paid from that time on:

	£
1910	99,355
1911	152,951
1912	187,001
1913	187,506
1914	147,326
1915	151,670

The following figures, for successive years, of issued share capital, output values, ore reserve gross values, and ore reserve profit values (where a record of these is available) form a fair index of the fortunes of the corporation:

Year	Issued Share Capital	Output Values to End of June	Ore Reserves Gross Value, October	Ore Reserves Profit Value October
	£	oz.	£	£
1898	74,000	2,665		
1899	125,000	8,037		
1900	130,000	32,964		
1901	155,000	17,977		
1902	155,000	26,858		
1903	155,000	115,834		
1904	155,000	161,100		
1905	155,000	172,962	51,000	
1906	155,000	131,346	215,000	
1907	155,000	188,528	219,000	
1908	155,000	173,810	418,000	
1909	168,584	174,369	2,000,000	
1910	200,900	306,323	1,910,000	
1911	212,216	428,130	1,685,000	600,000
1912	214,293	474,365	1,481,000	552,000
1913	214,293	460,531	1,505,000	574,000
1914	220,611	433,682	1,797,000	653,000
1915	220,611	447,257	1,986,000	830,000
		3,756,738		

From 1898 to 1903 the par value of the shares was £1; the £1 share was then split into five of 4s. each.

The increases in issued share capital, it should be explained, represent more (for the early days very much more) than a mere face value addition to available cash. It was a substantial share premium account rather than the original small provision of working capital which served to pay for the costly initial operations and the even more costly later alterations and additions to equipment, in part due to the change over from adit mining to deep mining and in part to more complex treatment methods being required.

THE MINES.—Geologically the property is characterized by the predominance of schists intercalated with and traversed by igneous intrusions. In the southeast corner of the concession there is a ridge of quartzite, a spur of the Dampia range, tilted practically vertical and striking, roughly, northeast and southwest. Over the rest of the area and probably overlying the quartzite, although the relative original position is by no means certain, is an undetermined thickness of schists of similar general strike and dip. Owing to pressure and thrust folds, considerable differences in local strike and dip are apparent. Phyllites and quartz schists more or less sericitized and dolomitized are prevalent types. In many instances the schists are somewhat graphitic, most markedly so where they have been subjected to considerable dynamic metamorphism. Igneous intrusions are various. To the northwest of the gold deposits at a distance of a mile or two, there is a well marked parallel line of granite bosses. A large intrusion of a more basic nature is represented by a wide dike on the southeast side. This may be contemporaneous with and of a similar nature to a small dolerite dike which cuts through, without displacing, the Obuasi vein between the 7th and 8th levels. In numbers of places greatly altered rocks occur which, although argillaceous and of schistose structure, may well be of igneous origin.

Striking roughly N. 30° E. there are several zones of fissuring, one of which may be regarded as the axis of the principal gold deposits. Typically this consists of a practically vertical fissure anywhere from two to thirty or forty feet wide, filled with more or less brecciated graphitic schist and, in places, quartz veins. Over some stretches the greater part of the graphitic filling is replaced by quartz. On or about the principal line are situated the Ashanti vein (with the Obuasi shoot and Insintsiam as branches or spurs off the same fissure), Ayeinm, Justice's, Old Chief, Tom Collins', and Blackie's. Southeast of the main line the Cote d'Or consisted of relatively small and poor shoots of quartz in a parallel fissure. On the northwest side of the main line, the Korkortaswia and Sansu orebodies appeared as more or less detached deposits. Not all these points are now being worked. It is not proposed to deal here with various detached orebodies or freak deposits, some of which were so small or so low-grade as to be profitable only while they were accessible to adits and shallow workings and which have now been exhausted or, as in the case of the low-grade Old Chief, will soon be exhausted, so far as adit mining permits. The principal mines on which the welfare of the corporation depends at present and which will be referred to here are Ashanti (which embraces Obuasi shoot), Ayeinm, and Justice's.

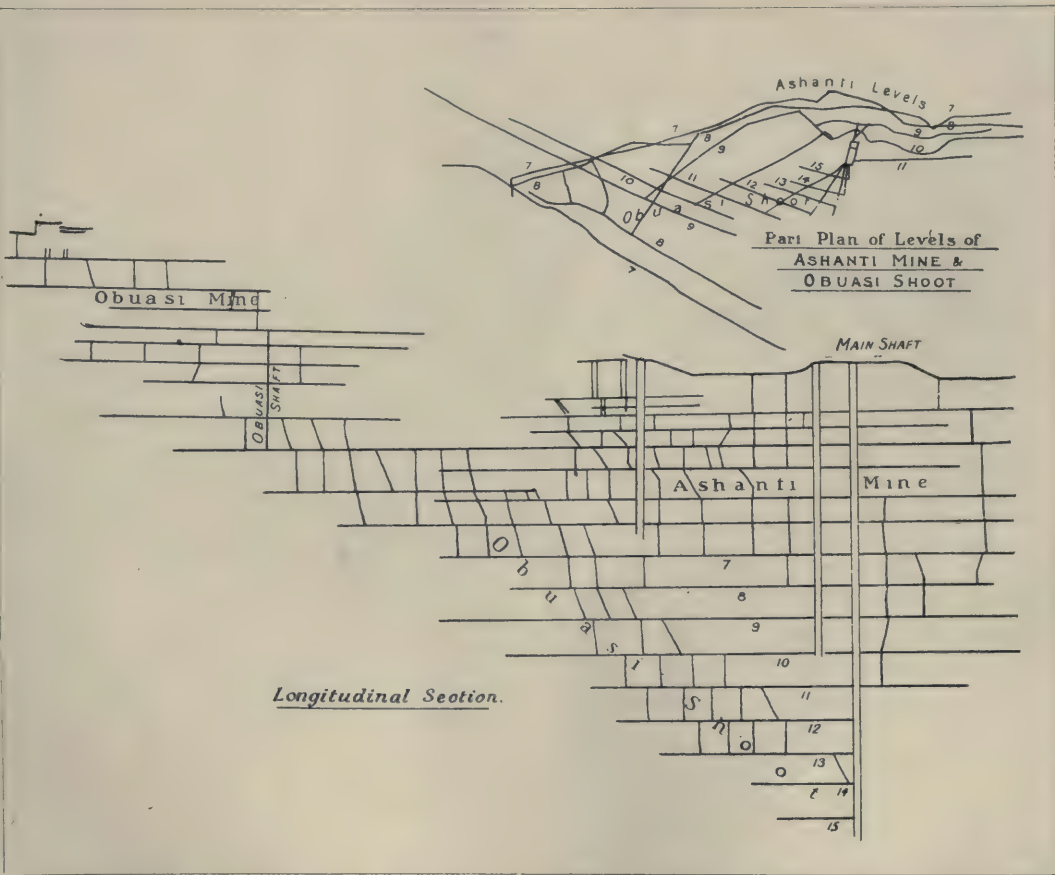
In Ashanti mine the orebodies on the main fissure have always been somewhat erratic. The main Ashanti vein is a very solid body of quartz running at some levels to a length of 1000 ft., and varying in width from three feet to forty feet. But the incidence of gold values is very irregular and at the lowest levels there is little profitable ore at present exposed. The Obuasi shoot, on the other hand, which, at the upper levels consisted mostly of isolated makes of rich quartz—lenses within a graphitic fissure—developed into a much more continuous and regular deposit from No. 3 level down, a poor zone occurring, however, between Nos. 6 and 8 levels. It consists of a quartz body about 500 ft. long and from 4 ft. to 20 ft. wide. It strikes N. 45° E. and dips toward the Ashanti vein but pitches so rapidly in a north-easterly direction that, in horizontal projection, it remains nearly parallel with Ashanti vein. The lowest level at present being developed is No. 16 (1500 ft.). According to the last estimate, at the end of 1915, there were 267,000 tons of 28 dwt. ore in reserve in the Obuasi shoot. The quartz is held in walls of graphitic schist and is generally of banded structure, owing to the inclusion of thin layers of this graphitic material ('streaky bacon' structure). Part of the gold is free and part is held in the sulphides, which consist chiefly of ordinary iron pyrite, of which there is about 3%, but also mispickel and small quantities of lead and antimonial sulphides. The graphitic selvedge on the foot-wall, sometimes many feet thick, is very treacherous especially if at all wet, and necessitates careful and expensive mining. A level driven *on* the vein, particularly if it touches the foot-wall at all, calls for constant repairs and, as the result of costly experience, the system which has been adopted in development is one of lateral drives and cross-cuts. It entails a great deal more dead work to begin with, but effects so great a reduction in cost of upkeep as to more than justify itself. By this system levels, instead of being driven on the vein, are driven parallel to it and about 20 or 30 ft. away from it. Cross-cuts are driven from the levels at intervals of 25 ft. and are put through the vein. Rises are put up from the cross-cuts to serve as boxholes and as bases for stope drives. These stope drives are kept about 8 ft. above the horizon of the laterals and, as they are filled as soon as the second stopes are started, there are no permanent openings left on the vein, but only the working stopes, the ore passes, and the filling passes. Practically all the stopes have to be timbered with heavy square sets and all have to be kept close-filled with waste. The maximum lift between levels is 100 ft. vertical, this having been proved the most practical and economical distance. The main shaft, a three-compartment vertical shaft 15 ft. 4 in. by 6 ft. 6 in., is over 1600 ft. deep. An auxiliary shaft 11 ft. 3 in. by 6 ft. is used for haulage of men, loads, tools, and timber, and, in part, for pumping. Both these shafts are steel setted with H girders and lagged with heavy corrugated iron.

An old shaft, the Obuasi shaft, sunk from an adit at the southwest end of the mine, serves as an upcast, ventilation having recently been improved by installing a Sirocco fan with its intake in the mouth of the adit. Ventilation is always a difficult problem in these mines, and the temperature and heavy atmosphere in some of the more graphitic workings, where these are not well ventilated, suggest that there is something in the nature of a slow combustion of a constituent of the graphitic schist. Possibly, however, the fermentation of the timber used in securing the ground may be responsible. The introduction of even large quantities of air from the surface is not as effectual as might be expected, for the air brought down is, most hours of the day, but little cooler than the underground temperature and sometimes actually hotter, and, most of the time, is so moist that there is no cooling effect due to evaporation.

Ashanti mine, that is, principally the Obuasi shoot, supplies some 6500 tons of ore to the mill monthly and accounts for more than three-fourths of the monthly output. The tonnage may seem small in relation to the amount of ore developed and to the number of stopes available (ore extraction is going on at 9 different levels), but stoping is necessarily slow, not on account of any difficulty in breaking ore, but because of the need of close timbering and filling of the stopes.

The Ayeinm deposit is a relatively short quartz body in the same main fissure as Ashanti, roughly pear-shaped in horizontal section. It is about 700 ft. long and varies in width from 4 ft. at the narrow end toward the southwest, to 60 ft. wide at the northeastern end. The grade is, on the whole, low and the incidence of the gold is particularly erratic where the vein is widest. Stoping is carried out selectively in the sense that poor sections at the northeast end are left unbroken. The vein has a slight underlay to the southeast (the contrary direction to Ashanti). The lowest level on Ayeinm is 400 ft. below the bottom (No. 4) adit. About the time when the ore above this lowest adit was becoming exhausted, a steel setted vertical three-compartment shaft was sunk from a point on the hill side 220 ft. above the adit and has since been continued to No. 8 level. Mining work at Ayeinm is simpler than at Obuasi and there is less dead work. The ground is, however, heavy and tends to come away in large blocks owing to horizontal heads traversing the vein. The stopes have to be provisionally secured with heavy pigsty timber and close-filled at the earliest possible moment. Surface soil is obtained for stope-filling through a rise in the southwest end of the mine. Ayeinm, as already mentioned, is a low-grade proposition (latest estimate of reserves 80,000 tons of 9 dwt. ore), and the 3000 odd tons mined per month represents only a small profit.

Justice's mine differs in many particulars from the other two. Originally the deposit deposit in the oxidized zone has the characteristics of a phyllite which, in addition to sericitization, has been modified by mineral impregnation, pyrite and mispickel (the latter in well defined prisms) occurring freely. The rock is also traversed by a network of fine quartz veinlets introduced by percolation during metamorphism. Carbon (graphitic) is an accessory constituent of the mineralized schist,



DIAGRAMMATIC REPRESENTATION OF WORKINGS IN ASHANTI AND OBUASI MINES, SHOWING THE RELATIVE POSITIONS OF THE MAIN ASHANTI WORKINGS AND THE OBUASI SHOOT.

was discovered in 1908 by J. N. Justice, then in charge of prospecting operations for the corporation. It is not a quartz vein, as the others are, but is an impregnation deposit consisting in the main of a mineralized micaceous rock partly schistose in structure. The general form near the surface suggests a pipe-shaped igneous intrusive which has become laminated by pressure. But this pipe shape may be due merely to the peculiar pressure folds in originally sedimentary schists. Petrologically the and a normal graphitic fissure lies to one side of the deposit and in part forms a foot-wall to the ore. At the surface the ore appeared as a partly schistose, partly gossany, outcrop stained brown with iron oxides, which occurred as fillings of cavities left by the oxidation of sulphide crystals. It was on the whole a most unlikely looking material to be gold-bearing, let alone profitable ore, as it only differed slightly in appearance from barren schists on many other parts of the property.

Fortunately it was the rule to assay everything at all out of the common and not to trust to panning. For it was found that samples assaying from 15 to 30 dwt. of gold gave only insignificant amounts of free gold in the pan and, had panning been relied on, the deposit would have been overlooked, just as, doubtless from the relative absence of free gold, it had never received the notice and attention of the natives. The position of the outcrop, topographically, allowed of a rapid development of the new discovery and, within eight months of the time when Justice's hill was an unconsidered 'somewhere' in the jungle there were 100,000 tons of profitable ore developed. It was speedily seen that a great part of the top of this deposit lent itself to open-cut working, and this method was adopted, with great success, for extracting all the oxidized ore. Within twelve months of the original discovery a special treatment plant was installed, and an output from this new source was being obtained. From first to last about 200,000 tons of oxidized ore was treated and yielded gold to the value of £400,000, most of this at a time when such an additional source of revenue did much to tide over a critical period of transition on other parts of the property.

Below the oxidized zone at Justice's practically none of the gold content is free, and there is reason to believe it occurs as an arsenide and is not merely held in the interstices of the iron sulphides and sulpharsenides. The bulk of the developed sulphide ore has not yet been worked. At the lowest adit, No. 3 level, a very large area is mineralized and more or less auriferous, and a classification into ore and waste is very much a matter of grade in relation to working costs. Two sections at that horizon are regarded as coming within the former category under existing conditions, and these represent about 65,000 tons of 11 dwt. material. From a winze at a depth of 100 ft. below No. 3 adit an exploratory drift has proved another section, apparently independent of the local enrichments above (which do not appear to reach to No. 4 level), measuring 250 ft. long and 20 ft. wide, and assaying over 15 dwt.

METALLURGY.—The metallurgical problems arising out of the variety of ores to be treated deserve some mention. Originally, ordinary stamp-milling and amalgamation, when applied to the outcrop ores of the class of Ashanti, Obuasi, and Ayeinm orebodies gave extractions which, when supplemented later by the cyanidation of the stored tailing, were sufficiently satisfactory. Later it became apparent that amalgamation followed by the raw cyanidation of the tailing was going to prove a most ineffectual treatment for the deeper level ores. Indeed on ore of about 15 dwt. value the extraction was found to go as low as 60%, with raw cyanidation of the sand, but without slime treatment. Amalgamation gave little enough at the best of times, and cyanidation gave worse and worse results as the admixture of deeper level ores became greater. The difficulty in cyanidation was probably due in part to the gold being in a state of combination with arsenical minerals, but partly also it was proved to be the result of the action of the graphitic material mixed with the ore. The effect of this material is to precipitate gold from its solution in cyanide, so that, nearly as fast as the gold is extracted by cyanide from one constituent in the tailing it is deposited on another constituent in an insoluble form (insoluble, that is to say, in cyanide solution). A raw cyanidation of the slime (which contained a large proportion of the graphitic matter) was, therefore, out of the question and no refinement of treatment in the way of finer grinding, concentration, etc., gave any promise of reducing the losses in tailing much below 5 dwt. per ton. Obviously any treatment which would reduce this loss would be worth considering, provided that the extra cost did not exceed the extra extraction. As the result of numbers of tests it was found that, by dry crushing and roasting the ore, the whole product so obtained could be satisfactorily treated in one operation by plain cyanidation. The question of cost of treatment was one which could hardly be determined by laboratory tests, so it was decided to erect an experimental unit of plant to carry out bulk treatment on these lines. This plant, erected in 1907, consisted of a rotary drier, a No. 5 ball-mill, and a duplex roaster, with relative cyanide vats, etc., and it speedily afforded assurance that the extra extraction obtainable would considerably more than pay for the additional cost of treatment as compared with wet-crushing, amalgamation, and cyanidation of sand and slime tailings, in spite of the fact that the sharp quartz was found to cause a quite unexpected amount of wear of grinding plates and balls in the ball-mills. In the light of confirmatory tests recently carried out on raw treatment, with the added benefit of a subsequent treatment which removes some of the gold precipitated on the graphite, it has been realized that the conclusion come to then was a sound one, for the grade and nature of the ore considered. The plant was expanded in 1908, and then consisted, essentially, of five ball-mills and two roasters. As this experimental installation did not lend itself to further enlargement, and was, in some respects, inconvenient, a new and larger plant on similar lines was erected on another site, and has been at work since 1910. All the Ashanti ore, and most of the Ayeinm ore is now being treated at this central treatment plant, for an extraction averaging well over 90%.

Justice's mine has presented another problem in treatment; indeed more than one problem. The surface ore, which, curiously enough, contained no free gold amenable to amalgamation, was found to yield its gold readily to cyanide solutions, under suitable conditions. But the clayey nature of the oxidized ore made it impossible to deal with it by simple vat leaching, whatever method of crushing was adopted. On wet crushing, fully 70% of the product obtained was a clayey slime. It was obvious that a slime plant would be required to allow of treating this material effectively. As the ore value was fairly high (about 15 dwt.), and the cyanide solutions would consequently be rich, a means of securing a thorough wash of the treated slime was regarded as an important consideration. It was therefore decided that the best method of filtration would be by means of filter presses. The first installation of plant for treating Justice's oxidized ore, which started working in February 1909, consisted, in addition to the stamp-mill already in existence, of hydraulic classifiers for separating the sand, three Brown agitators for agitating the slime pulp, three filter presses, with necessary filling and washing pumps, and leaching vats for the sandy portion of the crushed ore. The agitators and filter presses were duplicated a few months later, and the maximum capacity of the plant brought up to over 5000 tons per month. A sufficiently effective method of treatment was thus obtained for a relatively small outlay on new equipment, the mean of sand and slime residues running about 2 dwt. The same plant served for treating a similar schistose oxidized ore from Blackie's mine, and the more quartzose schist from Old Chief mine. The crushing was done in cyanide solution in each case.

HAULING WOOD TO THE MINE FROM THE JUNGLE.

Such sulphide ore as has so far been treated from Justice's has been dealt with by dry crushing and roasting, with subsequent separation, in cyanide solution, of sand and slime, and by then leaching the sand and agitation and filter-pressing the slime. Roasting has to be done very slowly and carefully, and consequently this combination process is a costly one; and as in addition the extraction is not so good as might be desired, the treatment of Justice's sulphide leaves only a small margin of profit. It is at present doubtful whether this method of treating Justice's sulphide ore, which yields a bare 80% extraction on 11 dwt.

ore, will be continued, or whether it will be found more advantageous to work the ore by wet crushing and concentration for a 65% extraction at a much lower cost. This question is in abeyance for the moment, as the Cote d'Or plant is working on ore from other sources, and it is desired that the Justice's sulphide treatment problem shall be tried out free from all complications due to admixture with other ore.

MINING AND METALLURGICAL PLANT.—With the exception of winding plant, a small compressor, boilers, electric light plant, carpenter's and blacksmith's shops at Ayeinm, the surface equipment is concentrated at three points.

At Cote d'Or mill, originally 50 stamps of 1050 lb., many items of plant, some of them of a provisional or experimental nature, have been added. Here the filter-press plant already referred to is at work on the treatment of Old Chief ore and a small quantity of Ayeinm ore per month. Roasting furnaces, originally erected for treatment of Ashanti ore, were later extended and used for the treatment of a large dump of old tailing. The treatment of Justice's sulphide ore, so far as it has gone, has also been done at the Cote d'Or mill. The plant is elaborate, and antiquated in some respects, but it serves its purpose for the treatment of various classes of ore which do not lend themselves to dry crushing, roasting, and vat leaching.

The Central treatment plant is a dry crushing mill, consisting in the main of two rotary driers, 9 ball-mills (No. 5), and 7 Edwards duplex furnaces, with the necessary means for re-elevating and conveying the ore at various stages. The hot roasted ore is cooled by sprinkling on large cooling floors, and is then transferred to the leaching vats, of which there are 42, of about 140 tons capacity each. The treatment is a lengthy one, taking from 16 to 20 days, or even more, according to the locality from which the ore is derived. The furnaces and ball-mills are driven, normally, by a 300 hp. electric motor, of which there are two installed, with a complete steam equipment acting as a standby. The supply of cooling water for the furnace rabbles is pumped from a neighbouring stream by electrically driven pumps, and, generally, the smaller items of machinery such as the rock-breakers, rotary driers, hoists, lathes, and pumps in the extractor house, aerial ropeway for conveying ore from Ashanti mine, endless rope haulage for residue trucks, etc., are all electrically actuated. The plant is, of its kind, an excellent one, but, like all dry-crushing mills, calls for care and attention to keep it up to its work, and entails a considerable bill for repairs and spares. The maximum capacity of the plant is about 9500 tons per month, allowing for one furnace and two ball-mills under repair or as standby.

The third congeries of machinery is at and about Ashanti mine. In addition to geared Robey winders at the main shaft and the auxiliary shaft, there is a Cornish pump installed down to No. 6 level, a Walker steam-driven air-compressor (nominally 12 drills, but, thanks to diaphragm valves, of considerably greater capacity), and a Robey engine driving three 70-kilowatt direct current generators. These items, all under one roof, are now reserve units, their work normally being done by a producer gas engine plant in an adjoining building. The gas plant, supplied by the Westinghouse company, consists of three 3-cylinder vertical gas engines, each direct coupled to a direct current generator. These are for the supply of electric power to the Central treatment plant and accessories, to electric pumps underground, to motors in the fitting shops and other points, and for the lighting of the surface, workshops, dwelling houses, etc.

In addition there is a 4-cylinder Westinghouse engine direct coupled to a Belliss & Morcom compressor set, which provides all the compressed air required underground in Ashanti mine. Gas for the engines is provided by a pressure plant made by the Horsehay company. This works on anthracite and consists of two nominally 700 hp. producer units and one 300 hp. unit, with coolers, scrubbers, and gasholder, etc. The gas plant, working under West African conditions and so far from the makers' works, is at a disadvantage, but has served its main purpose in reducing the firewood consumption and lessening the anxieties due to shortage of surface labour at certain seasons of the year.

As far as is at all possible, the use of timber for structural purposes has been avoided. All head-gears are of steel. Ore bins are built of standardized sections of steel frames. The mill buildings and power house, fitting shops, stores, etc., are steel framed. The carpenters' shops, with saw mill, and the fitting shops are well provided with machine tools. A small foundry produces castings for spare parts of machinery.

WORKING COSTS.—Having regard to the conditions it is hardly to be expected that working costs at Ashanti would compare very favourably with those in many other parts of the world. To these conditions must also be added the circumstance that working is on a relatively small scale. The benefits and economies of large scale operations are not felt.

For the financial year ended June 30, 1915, the costs at the mines on 131,236 tons treated were as follows:

	Per ton s.	d.
Mine development	6	5·04
Ore extraction	8	6·46
Re-timbering existing workings	1	3·15
Ore haulage on surface		5·66
Ore treatment	13	5·62
General charges	4	8·63
	34	10·56

	Per ton s.	d.
Amounts written off (10%) from main shafts, plant and machinery, works and tramways	3	5·69
Total costs	44	3·73

These figures are a measure of the extractable value required in order to cover all expenses, working under the conditions existing in 1914-15. It is by the above method of calculation that published estimates of monthly profits earned are obtained, and consequently these estimates approximate very closely to the amount available for distribution as dividends. It should be mentioned that the above costs represent the expense of dealing with a mixture of various classes of ore, some of which are relatively cheaply mined and treated, and others are much more costly. Obuasi ore, for instance, has cost more than the above figures would imply; Ayeinm and Old Chief, on the other hand, very much less. This is, of course, a consideration which has been taken into account in estimating the profit value of any part of the general ore reserve.

Pay-day at the Ashanti Mine.

These costs, it will be noted, included all expenditure on development work. Main shafts and construction work were charged to capital account, but the charge of 10% for depreciation exceeded the actual expenditure on these items for the year in question.

Additional to the above costs are:

	Per ton s.	d.
Government royalty (5% of gross output)	3	4·90
Freight and insurance on bullion	1	1·91
General expenses, London, including directors' fees	1	4·67
Bringing the costs up to	40	10·04

Labour.—It may not be out of place to close this sketch with a few remarks on fuel and labour, subjects which present problems common more or less to all West African mines. The white worker in West Africa is primarily a supervisor of native labour, and it is on his capacity to direct natives intelligently that his value depends, much more than on any output of personal manual labour of which he may be capable. Experience of local conditions is therefore a valuable asset. Unfortunately the climate of the Gold Coast militates against anything like continuous or, in most cases, long service on the part of Europeans, and there is therefore a continual infusion of new white employees, inexperienced in dealing with natives. But this drawback is to some extent minimized by the class of native labour which is available. The term 'Gold Coast native' covers a number of races available for mine labour, the bulk of these being greatly superior to the South African kafir in intelligence and aptitude for learning handicrafts, and, allowing for different climatic conditions and a less robust physique, very little inferior in actual capacity for sustained effort. The Ashanti is most at home in the forest, felling and cutting trees for firewood, but he is commencing to undertake actual mining work and is finding his way into the fitting shops. Fantis, Krepis, Appolonians, Kroos, etc., provide the bulk of underground labour, and very efficient many of them are. The actual timbering is done by natives, the timber being prepared by native carpenters. Natives have been trained to run any machine in the fitting shops, to do most of the blacksmith's work, and to show their natural neathandedness in moulding in the foundry, which at a pinch can be run entirely by them. The winding engines and locomotives are driven by natives. Educated natives assist in such clerical work as store-keeping and time-keeping, and in the assay office most of the work on ordinary routine samples up to the finish of cupellation can be entrusted to them. The duties of the white staff in the metallurgical plants are almost entirely supervisory up to the stage of actual clean-up.

FUEL.—As regards fuel supply, firewood, in Ashanti at least, is incomparably cheaper than imported coal, and the supply of timber is still fairly abundant. But as fast as the jungle is cleared, the open spaces are appropriated for the planting of food stuffs. This, up to a point, was of advantage to the corporation, for the more abundant the supply of food became the more inducement there was for natives to settle at Obuasi, and thus to provide a surplus labour supply. Latterly, however, there has been a tendency to go in more and more for growing cocoa, which is a highly lucrative crop. The effect of this is that at certain times of the year a very large proportion of surface labour, particularly of that engaged in firewood cutting, and even of some of the underground labour, leaves its work to plant or to gather cocoa and to carry crops to the trading centres.

The purchase of such surplus stock as can be obtained during months when the supply is in excess of the immediate requirement is insufficient to provide entirely against the resulting temporary stoppages of firewood deliveries. It was for this reason that the producer-gas plant was installed, in order to reduce the demand for firewood. Nevertheless the consumption is still considerable, and the edge of the virgin jungle is now a long distance from the working centre. There are no less than 25 miles of narrow gauge 2 ft. lines in use for hauling ore, firewood, and mine timber. The ore trucks and firewood trucks are hauled by locomotives, of which seven are continually at work in daylight hours.

CONCLUSION.—It would of course be absurd to say of any of the gold mining companies on the Gold Coast that they were actuated by altruistic motives in commencing operations. On the other hand it is quite justifiable to claim that gold mining has directly and indirectly proved a great civilizing influence, which is perhaps more noticeable in Ashanti than in other parts of the country. The direct effect of the gold industry has been to teach practical handicrafts to innumerable natives, and thus to prepare them for useful citizenship. Indirectly the clearing of the jungle, however unsound it may be from a forestry point of view, has given an impetus to agriculture, which nothing else could have effected in the time. Whatever may happen to the gold mines within the next twenty years, it is impossible to conceive of the Ashanti, who has a natural eye for the main chance, voluntarily abandoning the role of a 'man of affairs' and reverting to the bad old ways of a comparatively few years ago.

Shipments of any material not directly intended for war purposes into Russia, via the port of Archangel, will be allowed only by obtaining a special permit from the Secretary of the Commission Internationale de Ravitaillement, India House, Kingsway, London. Intending shippers are required to give complete details of shipments, and are warned that application for a permit in no sense guarantees that shipment will be allowed. Bound books of any description are refused for transmission through the mails to Russia.

MICA IN THE TRANSVAAL

By W. T. HALLIMOND.

The writer gives some information relating to the mica deposits in the Oliphant's river district of the northeastern Transvaal, describing the various qualities of the mica and the methods of working.

DURING five months of last year—from May to October—I was engaged by an English mica company on some special work on Oliphant's River mica district in the northeastern Transvaal, and a few notes thereon may be of interest to your readers.

Until a year or two ago travelling to the mica district was a long and weary undertaking by coach or donkey wagon. The Selati railway via Komati Poort, or more recently still by the Pietersburg-Messina railway branching off southeast at the station Zoekmakaar, has brought the Murchison range and the mica district within 26 hours of Johannesburg by train. Travelling by rail from Komati Poort to Zoekmakaar or Messina, you enter the mica belt at the Oliphant's river. The river in its normal state is at this point about 180 ft. wide, but the girder bridge which crosses it is of seven spans of 120 ft. each. Mica Siding, the stopping place for the mica district, is about three miles north of the river, and is situated in the centre of the mica belt. The distance from Komati Poort is 143 miles, and from Delagoa Bay about 200 miles. The country in the Oliphant's River district is thickly wooded, and in many places the bush is almost impenetrable. There is one main road from Mica to Leydsdorp and thence to Pietersburg, but otherwise the only roads are Kaffir footpaths, and walking on these is arduous, and rough on shoe leather, owing to the small sharp-edged fragments of pegmatite rock which cover the surface of the ground. The landscape may be described as undulating, with here and there a prominent kopje or hill relieving the otherwise unbroken stretches of bushveldt. Few of the tributaries of the Oliphant's river flow continuously. One notable exception is the Makoutsie river, which enters the Oliphant's just above or west of the railway bridge already mentioned. The Makoutsie river drains a large watershed toward the northern extremity of the Drakensberg range of mountains. It flows through the western end of the mica belt, and provides the only water supply for the miners working in that vicinity.

The mica belt, from a geological point of view, strikes almost due east and west. The pegmatites in which the payable mica is found, traverse and intrude themselves into the older rocks of gneiss and mica schist in most peculiar fashion, characteristic of the mica-bearing pegmatites. Whatever the origin of the pegmatite veins, sheets, or masses—and it is a matter of extreme difficulty to solve, owing to the intense metamorphism to which the older rocks have been subjected—it is in these pegmatites that the mica is found. The mica is of the muscovite class, and is developed in crystals of varying size from small spangles up to sizes which are of high economic value. Little systematic prospecting has been done by the numerous syndicates and individuals who have spent their money in the neighbourhood. The prospecting has been of a guess-work nature, with-

THE AUTHOR, STANDING BY A KAFIR HUT.

out any heed to the strike or trend of the mica veins, which are so easily traced from east to west. There are many veins running parallel to each other, but differing greatly in the quality and nature of the mineral. There is a green mica, which is found in thick veins and huge pockets; but with this class only a small proportion can be produced in marketable form, for so much of it breaks up on dressing. There is also a good class of mica which is spotted and stained. Many people have condemned this class without investigation, on account of what was supposed to be metallic staining. This doubtful objection to the stained mica has now been finally disposed of by electrical tests; and samples of this class of muscovite, sold in London, brought even better prices than Indian mica, and was specially bought for electrical work. Then there is a third quality of clear brown mica of excellent quality, and often found in large sizes, free from flaws and lines, and when split is beautifully clean and elastic. A notable characteristic of these three qualities of muscovite is that as far as I have investigated the trend of the mica-bearing pegmatites the green mica is found on the south; the stained class sometimes mixed with the green, but more generally running parallel to the north; and the clear brown, always the vein occupying the northern position. There is undoubtedly several 'runs' or 'leads' of mica veins, but the three classes will always be found in the positions mentioned. The mica veins can be easily followed by careful observation of the outcropping pegmatite; but it is only by systematic prospecting on the lines of strike that the payable mineral will be discovered.

It is noticeable that the bulk of the work done by individuals and small syndicates has been in opening up the green mica. This is accounted for by the fact that this class is found in larger veins and consequently is more easily quarried. When, however, it comes to cleaning and splitting, the result has been so disappointing that prospecting work in most instances has been entirely abandoned. Why attention was not turned more to the stained and clear brown qualities is difficult to understand. There is only one company working at the present time and some good clear brown mica is being produced, giving a good percentage of sizes over 4 by $1\frac{1}{2}$ in.

All work carried out so far has been done by open quarrying. Owing to the undulating nature of the country, underground mining will be unnecessary in most cases for many years to come. This method of working is naturally not only much cheaper than mining, but enables the workmen to extract the 'books' of mica in much better condition than would be the case by stoping in narrow underground workings.

Good deposits of commercial muscovite exist for many miles to the east of the railway toward the Portuguese border. Nearly all the ground in that direction belongs to the Union of South Africa Government, and much of it has been pegged at different times, but the licences have been allowed to lapse through prospectors only having pegged the ground for an immediate deal, and with no intention of doing any useful work.

Base-metal licences under which this ground may be worked cost only one penny per claim for the first year and afterwards 6d. per claim. Unprincipled prospectors have taken advantage of the Government's liberality in making the first year's licences only one penny per claim. They pay for the twelve months, after which there is also three months' grace, in which period the licences may still be paid if the necessary fines are also forthcoming. However, the wily prospector who only wants to sell and not to work, pays no further licences nor does he pay the fines. Some friend who stands in with him comes along and repegs the ground and so gets another 12 months, and three months' grace at one penny per claim for twelve months, and so it goes on *ad infinitum*.

MICA QUARRY, A KAFIR IN FORE-GROUND HOLDING TWO 'BOOKS OF MICA.

Taking into consideration the great area of the mica belt, the proportion of country opened is very small. Such are the results of the most recent working, however, that in my opinion they warrant a much larger expenditure of capital for the purpose of more thoroughly investigating, and systematically prospecting, the mica-bearing ground to the east and northeast as far as the border of Portuguese East Africa. The present demand for mica warrants careful prospecting, and such work appears to be worth the while.

DISCUSSION

Glass Top Concentrating Tables.

The Editor:

Sir—I have received from Captain W. Thomas, manager of the Tincroft mine, some figures of his tests in connection with wood and glass surfaces. Though the results are incomplete, they may possibly be of interest to your readers.

The pulp tested was similar in constituent minerals, tin oxide, copper sulphide, arsenical pyrite, and wolfram, to the pulp tested at the adjoining mines of East Pool & Agar, the figures of which latter test you published in your January issue. As any and every structural fault, either in the tables used, or in the method of laying the glass segments thereon, was common to both machines, the figures I give should afford an opportunity of comparing results, obtained over considerable periods at Tincroft, with approximately correct glass surfacing, with the trial run at East Pool & Agar with surfaces not specially adapted to the pulp treated.

Possibly the tabular statement may be considered as not being in order, seeing that the tonnage treated is not stated, and the recoveries of other minerals not given. To such objection I can only say that, after a year's working of these surfaces at Tincroft, these are the only official figures I have seen of the results obtained there, and these reached me only during the past few days. It is to be regretted that the recoveries of sulphide content of the pulp are not available, as they should throw a lot of light upon the two December tests.

The pulp tested was a green tailing, resulting from passing the original battery pulp over percussion tables, vanners, and other modern concentrators, and subsequent settlement. Assuming that these initial and prior operations upon the battery pulp removed 60% of the mineral content of the ore, which I submit is a reasonable assumption, then it follows that 40% of the original mineral content passed into this green tailing; and the above 75% recovery of the tin content by the glass surface used would of course represent 30% of the original tin content of such ore, making in all a 90% extraction in a workable first product. This does not represent the limit of extraction of the mineral content on properly standardized glass surfaces, but the limit of the particular one used.

Such tin, or other mineral, as did escape, can be tackled on another surface, and it can easily be shown that it consists:

(a) Of small quantities of extremely fine mineral, not beyond surfacing for, but beyond the catching power in a one-surface operation of the specific glass surface necessary for the retention of the general tin content of the pulp in question, requiring for its recovery a different construction of surface than can be used for the recovery of the main quantity of tin present, and with which it is associated. In a word the latitude of the retaining power of one glass surface in relation to the enormous number of different sized mineral particles present in such pulp is very great, but not so perfect as to embrace the whole.

(b) Small losses due to structural, but remediable, defects in the tables employed, and

TESTS OF GLASS AND WOOD SURFACES AT TINCROFT.

Date	Feed	Concentrate		Tailing		Recovery %	
		Wood	Glass	Wood	Glass	Wood	Glass
	Pounds SnO_2 per ton						
September 1915	25·4	45·08	88·89	9·5	6·35	62·59	75
	25·4	50 16	108·5	9·5	6·35	62·59	75
	24·7	45·08	88·89	9·5	6·35	61·54	74·28
December 1915	19·2	32·5	43	5·5	4·24	71·3	77·8
	10	29	29	4	3·5	60	65

NOTE.—The concentrates contain from 15 to 20% of arsenic. The assay-values give SnO_2 only.

in the manner of laying the glass segments thereon.

The above table of figures, therefore, does not show what correct surfacing can now do, but what the first commercial machine with an approximately correct surface, in one operation upon the pulp in a Cornish mine over extensive tests, has obtained, without any particular care in relation to the essential requirements of the peculiarities of the surface, and in comparison with wood surface under identical conditions save for the fact that the glass surface was fed with a larger tonnage of pulp in a given time.

With all their incompleteness, taking these figures as they are, and casting aside for the moment decimal fractions, the glass surface results average about 13% additional tin oxide recovery in a first product of 40% higher assay-value than the wood surface. As considerable experience has shown that in subsequent operations still greater advantages accrue to the glass as against the wood, should not such results be an incentive to examine this process more closely as a whole, rather than tinker with one small detail of it? Even a final 20% additional recovery would allow of a correspondingly lower grade of ore being mined at the same profit.

May I thank your correspondents, Messrs. Trewartha-James, Stutchbury, Macartney, and Gregory, for their respective criticisms. I desire to make one observation as to Mr. Trewartha-James's illustration of glass surfaces which appeared in your February issue. I fear he has not yet fully apprehended their requirements, or that extremely important structural differences are not visible to the naked eye. Certainly those he has published, with one exception, are undesirable, as in my opinion they embody the maximum of what is injurious and the minimum of what is essential.

I hope at a later date to send you a full description, with illustrations, of glass surfaces in relation to ore concentration, how they can be made, and how they should be.

W. MORLEY MARTIN.

Redruth, April 29.

[We publish this letter on the general principle that in these days we must help every inventor, especially an inventor who has an apparatus that promises to increase the extraction of tin. We agree with Mr. Martin that the details of results so far published are scanty, and we therefore welcome the promise contained in his concluding paragraph.—EDITOR]

The Editor:

Sir—Your article on concentration, in connection with glass-top tables, appearing in the issue of January last, is interesting and to the point. But I venture to point out that the figures on page 32 giving the results of tests are discrepant. No doubt this was caused by two new pieces of apparatus being employed, when the test was directed to the study of one only. The other piece of apparatus to which I refer is of course the "particularly efficient automatic sampler" mentioned in the concluding sentence of your article.

If this sampler had not been used to determine the flow, but this figure derived from the weight of concentrate produced, together with the assays of head, tail, and concentrate, quite different results are obtained.

The formulæ I employ are:

$$\text{percentage of recovery} = \frac{100\,b\,(a-c)}{a\,(b-c)};$$

$$\text{and ratio of concentration} = \frac{a-c}{b-c}$$

where A = weight of feed
B = weight of concentrate
a = assay of feed
b = assay of concentrate
c = assay of tailing

I give herewith the results obtained by these formulæ, and compare them with the figures quoted in your article:

	Wood Sampler	Wood Formula	Glass Sampler	Glass Formula
Percentage of recovery	44·40	51·80	34·70	36·78
Ratio of concentration	3·66:1	3·15:1	9·93:1	9·55:1
Weight of feed in pounds	5690	4901	8412	8061
Tailing by difference	4133	3344	7565	7214

R. T. HANCOCK.

Jemaa, Northern Nigeria, February 23.

[Mr. Hancock may possibly be right in attributing the discrepancy to faulty work by the automatic sampler. When we read the figures before publication, we were suspicious of them because of the identity of the assays of the tailing in the two tests. On working out the calculation we found the figures did not check, and we attributed the discrepancy to an error in transcription in connection with the assay of one of the tailing samples. We had no time before going to press to refer the figures back to the mine. Knowing that the subject was of timely interest, we decided not to postpone the article, but to publish the figures as they stood. We give the formulæ on which Mr. Hancock bases his calculations, though these are of course already known to most of our readers.—EDITOR.]

Proposed Cornish Mining Board.

The Editor:

Sir—The proposal of Mr. Moreing that a mining board should be formed by the heads of the Cornish mining industry, cordially supported by Mr. Goold at Grenville United mines meeting and by others interested in the mines, has much to recommend it and nothing against it, if inertia and anything savouring of old time rivalry can be set aside in the common interest. We have had many attempts to obtain collective action, some of which were long successful. There was the Mining Institute of Cornwall and afterwards the Mining Association of Cornwall. Then came the London and West Country Chamber of Mines, and later still the Cornish Institute of Mining Engineers; with a certain amount of united endeavour in conjunction with the Royal Cornwall Polytechnic Society, the Royal Institution of Cornwall, and the Royal Geological Society of Cornwall. Broadly speaking, all these institutions have sought the betterment of the miner and the mining industry, by stimulating invention, promoting discussion, and fostering the exploitation of the hidden mineral wealth of the country. At times there have been emergency meetings of the executives of particular mines under stress of labour, water, or royalty difficulties; but a small yet representative board is undoubtedly needed to place the mining industry on a more solid and durable basis.

It may be that the mines around Carn Brea hill will long be worked as separate or small-group concerns, although in some countries a spacious policy might have effected amalgamation, with efficiency and economy, with regard to properties covering such a small and compact area. But, assuming that each company has to grapple with its own problems, there is ample scope for a permanent mining board to exchange ideas and formulate policies with regard to the disposal of water, experimenting with new tin-dressing plant, tracing and reaching untapped mineral deposits, negotiating with mineral lords with regard to dues and other matters, adjusting labour difficulties, and watching legislation likely to affect mines or miners. The board should not be unwieldy, yet should be large enough that the financial, engineering, underground, and surface features of the mines would be represented. The lords might also be represented on the board, with a view to amicable co-operation with the investors. Who will take the initiative? Mr. Moreing, as a newcomer and a mining engineer of world wide experience and repute, seems an ideal organizer, but he must put his back into the work if the proposal is not to die as a weakling. He should convene a private meeting of the heads of the mines and come to it with certain concrete proposals for discussion. The Cornish Institute has already done much good work, but there are still several leading mine managers who stand aloof. Will these respond to an invitation to join a mining board? You can only tell by convening a meeting. Mr. Moreing could, of course, feel the pulse of the patient fairly well by personally interviewing the principal people whose co-operation is necessary, before bringing them together to formulate rules and conditions of membership. The difficulty of precedence might be overcome by not appointing a president or chairman for a definite period, but varying the chairman as at the Cornish tin ticketing. If there were no rocks in the river to be negotiated we should long since have had effective and enduring organizations to develop our important mining industry. A tactful pilot is needed, and personal magnetism will go a long way. We all know that there should be no rivalry, no jealousy, no undue emphasis of individual rights, no cold shouldering of promising inventions, no indifference to the troubles of a neighbour because, at the moment, we are not in similar straits. And I hope Mr. Moreing, *The Mining Magazine*, and Mr. Goold will be successful in giving concrete expression to the need of co-ordination and unity in matters which, at one time or another, are of vital importance to all who are connected with Cornish mining and have its welfare at heart.

HERBERT THOMAS,
Managing Director of *The Cornish Post and Mining News* and other newspapers.
Camborne, April 20.

The Editor:

Sir—Your article on a Proposed Mining Board in your April issue interested me greatly. Having in view the research work that is to be carried out in the county, I consider that a Mining Board of Cornwall would be a great asset, provided that the number is limited, and the members practical mining men only, together with the representatives of the various mineral lords, on the lines suggested by Mr. C. A. Moreing. I believe that a scheme of this kind would meet with the ready support of the mining directors.

J. M. HOLMAN.
Camborne, April 26.

SPECIAL CORRESPONDENCE

JOHANNESBURG.

EARTH TREMORS. — The report of the Witwatersrand Earth Tremors Commission has been issued. The conclusions that the tremors are entirely due to mining operations conform with the views of most engineers, but it is to be regretted that no definite recommendations are made with regard to an improvement in the mining methods likely to reduce these tremors to a minimum. The report states in a concise and intelligible manner the result of leaving pillars too small to withstand the weight of the superincumbent strata, but while recognizing the mischief caused by these inadequate pillars, the Commission considers that the total abolition of pillars is impracticable, as it might result in the pressure being thrown on the stope faces, and thus cause severe rock bursts. Most miners will agree that small inadequate pillars in deep mines constitute a snare, but in the very deep mines on the Rand adequate pillars to resist any movement would be of such large dimensions that successful mining would become impracticable. For instance, it seems probable that at a depth of only 2000 ft. one-third of the reef would have to be left in the shape of pillars to prevent any movement of the hanging wall taking place, and at least one-half of the reef at a depth of 4000 ft. It is evident, therefore, that if these earth tremors are to be prevented by the leaving of adequate pillars below ground, a depth will soon be reached at many of the mines on the Rand where mining will become impossible.

However, although the Commission considers mining without pillars impracticable, the report recommends that where drift pillars show a tendency to burst, they should be made larger until the stope is exhausted, and mined as soon as possible thereafter, or should be entirely discarded and replaced by substantial packing. Another recommendation of the Commission is that in case of future shafts the pillar left for the support of any deep level shaft should be never less than 500 ft. in diameter, without, be it noted, being regulated by the depth and dip of the reef. Construction of incline shafts and drifts in the foot-wall is also recommended where practicable.

Taking the report as a whole, there are few recommendations apparently upon which it will be possible to base legislation with the object of preventing future earth tremors. Nor as a result of the investigations of the Commission does it seem likely that any drastic changes in methods of working will be introduced. The sum and substance of the report seems to be to the effect that, where modifications of existing methods of working will result in greater safety and economy and at the same time in diminishing the frequency and severity of these earth tremors, it is expected that the mines will adopt such modifications. But beyond the few recommendations quoted from the report, there are no definite indications as to how these improvements in mining methods can best be achieved.

FAR EASTERN RAND.—A great deal has been said lately about the prospects and future of the Far Eastern Rand, a liberal definition of which will include that section of the Witwatersrand goldfield extending north and east of Boksburg, as likewise the unproved tract to the south of that town. The area is estimated to be in the neighbourhood of 90,000 claims, of which quite four-fifths are vested in the Union Government by virtue of the Gold Laws. The fact that a great proportion of this large and unproved goldfield is vested in the State has to some extent militated against its development. The Government Areas of Modderfontein was let on better terms for the Government than many of these uncertain areas are considered able to command. The Government appears to hold out for similar terms elsewhere, and for this reason past offers to lease ground have proved unsuccessful. A Commission has recently gone into the matter, and their report and recommendations are expected to be published in the course of a few days.

The value of this huge area is uncertain for various reasons. It has long been recognized that the gold occurred in separate areas or zones, separated by stretches of comparatively barren ground. Dr. Mellor, Assistant Director of the Union Geological Survey, after a thorough investigation of the Rand goldfields, has attributed this to a deltaic origin of the conglomerates, an explanation which also throws considerable light on other peculiarities pertaining to the conglomerates of the Witwatersrand. The Far East Rand has the further drawback of carrying only one workable reef —the Main Reef Leader—and not several reefs as on other portions of the Rand. The reef also as far as proved has only a small inclination, and therefore carries a minimum tonnage per claim. On the other hand its slight inclination should enable the reef to be available for exploitation throughout the whole area. Occurring as it does in the shape of a basin, the central portion may be assumed to be flat, and nowhere throughout the area of the basin ought the reef to lie much beyond a depth of 5000 ft., a depth at which several mines are at present working on the Rand. It is of course impossible to say what proportion of the area of the Far East Rand may prove to be payable, but judging from the small amount of work already done, it may possibly be one third. With regard to the probable scope for mining operations, it is not unlikely that eventually sufficient ground will be found for, say a hundred companies, which practically means a duplication of the Rand.

There seems some difference of opinion with regard to the amount of capital required to equip and bring to the productive stage this large area of the Far East Rand, the Minister of Mines giving fifty millions sterling as the probable sum. If, however, heed be paid to what has been found necessary by other mines in the Far East Rand to bring them to the producing stage, a hundred millions sterling would appear to be nearer the amount of cash capital required.

No matter from what aspect the possibilities of the Far East Rand may be regarded, and due allowance be made for its numerous drawbacks, its minimum potentialities should be about equal to the rest of the Rand lying west of Boksburg. Supposing that for argument one-fourth of the ground ultimately proves to be payable, and due allowance be made for its solitary reef and flat dip, the payable tonnage will still come out at over 500 million tons, a tonnage approaching that already crushed on the Rand during the past thirty years.

WEST AUSTRALIA.

STRIKES.—Following upon the strike of the firewood cutters, which disorganized the work on all of the mines at Boulder and Kalgoorlie, comes a decision of the Labour Unions that their members should not work with enemy subjects, which has caused a decrease in the output of several of the mines. The Austrians, who were interned earlier in the war, came from those parts of Austria which were in sympathy with the enemy, but there were left quite a large proportion of Slavs, who were antagonistic to them, and loyal to us. However, this proved to be too good an opportunity for the extreme section of the Miners' Union, and they were able to secure the expulsion of these men from the mines. The trucking and shovelling work in the mines has to a very great extent been monopolized by foreigners, owing to British workmen avoiding this class of labour. The managers, on their part, have no desire to employ enemy subjects, but find considerable difficulty in securing sufficient men to enable them to maintain their outputs. Nearly all of the single men on the goldfields have enlisted, and many of the best of the married men also; so much so that the President of the Chamber of Mines has issued a note of warning to the Defence Department, saying that if the gold output is to be maintained, and it is obviously necessary that it should if possible be so, they should try and devise means to take others who could more easily be spared. There are unfortunately still thousands of men around the cities of the Commonwealth who rarely if ever work, living on race meetings and their unfortunate dupes. The thinking portion of Australia, both in the Labour and Liberal ranks, would welcome conscription.

WESTONIA.—After a struggle to make ends meet on low-grade ore, the Edna May Central, in cross-cutting for what is known as 'wash' at the 75 ft. level, cut a new lode, and the average at this level is given as 70s. over a width of from 9 to 12 ft. for 180 ft. in length and of equal width and value in both faces. At the 150 ft. level, the lode has been cut, and the width is maintained, and the general average in value is at least 160s. per ton. Cross-cutting from the 250 ft. level is being pushed, and the results are anxiously awaited. The management has decided to increase the output to 3000 tons per month, and the shareholders will soon be receiving regular dividends. One pleasing feature is that this mine has been worked on good lines, the mill was erected to enable economical work to be done, and the working costs have been low for only ten stamps. The mine has always been open to visitors, and the management deserves the good luck which has befallen them.

The Edna May Deep Levels shaft is down 400 ft., where it struck a further inflow of 13,000 gallons of water per hour. According to the bore-hole results the lode (Edna May) should be cut by cross-cutting 15 ft. at 480 ft. The shareholders are asking themselves the question whether the water now being pumped from the lode in the Edna May Lease, amounting to 2,000,000 gallons per day, will prevent their reaching the lode in their ground.

It will be remembered that the bore-hole from the bottom of the Edna May Deeps shaft proved the lode to be worth 120s. over a true width of 21 ft. Should this be confirmed at the 480 ft. level, it will, together with the development in the Edna May Central, attract a considerable amount of attention to the field.

TORONTO.

PORCUPINE.—Great activity prevails in the Porcupine gold area, and many companies are increasing their equipment. The Dome is installing three Hardinge ball-mills, one of which is now already in place and foundations for the second are being laid. A secondary crusher will also be added to reduce the ore before its delivery to the mills. Development at the seventh level shows a width of 244 ft. of ore, which will run over $5 to the ton, with portions of considerably higher grade. The output shows a steady increase, the March production being $176,590, and with the increased capacity of the new equipment it is expected that the year's production will approximate $2,500,000. The arrangement giving the Dome an option on the Dome Extension has been completed, subject to ratification by the shareholders. The option runs until October 15, 1917, and if it is taken up the Dome Extension shareholders are to receive 46,000 shares of Dome stock. In the meantime the Dome is permitted to do exploration work on the property, while the Dome Extension management will go on with development on the 200 ft. level. The usual 4-weekly statement of the Hollinger for the period ending February 25 shows gross profits of $169,905 from the treatment of 30,658 tons of ore of the average value of $9·01 per ton, at a cost of $3·07 per ton milled. The annual report of the Dome Lake for 1915 shows receipts of $80,707 and profits of $5776. The amount of ore treated was 11,827 tons of the average value of $9·12 per ton, with an extraction of about 80%. The new cyanide plant is now complete and ready for operation, which is expected to increase the recovery to 95%. Underground developments have been attended with highly favourable results, ore encountered on the third level assaying as high as $30 per ton. The report of the McIntyre for the first quarter of the year shows profits of $97,128. A total of 27,248 tons was milled of the average value of $7·74 per ton, with a recovery of $201,110 or 95·4%. Operating costs were $3·85 per ton. Work has been started on the tramway from the Jupiter-McIntyre to the McIntyre Extension. The Schumacher has discovered four quartz veins in the cross-cut to the north on the 600 ft. level, which contain good milling ore. The results of operations on the Vipond for the three months ended March 31 were the production of $53,348, from 11,810 tons of ore of the average value of $5·24 per ton, at a cost of $4·54 per ton.

COBALT.—The silver mining industry has been stimulated by the rise in the price of silver, which has had a marked effect on Cobalt stock issues, resulting in an active market. The increased interest is shown in the re-opening of several properties in Cobalt and the outlying districts which had been closed down. It is hoped that by the adoption of the oil flotation process the life of the district may be considerably prolonged, by making it possible to treat ore of a lower grade than has hitherto been profitable, and also to treat old dumps of tailing. The Buffalo has installed a flotation plant with a daily capacity of 600 tons. The McKinley-Darragh expects to have a 150-ton plant in operation next month, and the Nipissing has treated several hundred tons of ore in an experimental plant attached to its low-grade mill. The Callow pneumatic process is that employed. The annual report of La Rose Consolidated showed a production of 1,135,142 oz. of silver of the net value of $526,996, with profits of $230,662. The surplus on hand was $937,490. There is very little high-grade ore now in sight, and the low-grade ore has been reduced to 10,000 tons. The production of the Nipissing during 1915 was 4,097,391 oz. of the gross value of $2,222,256, yielding a net revenue of $1,441,428. The surplus on hand was $1,786,260. The ore reserves were 8,912,718 oz., as against 10,017,076 oz. at the end of 1914. During March the Nipissing mined ore of an estimated value of $169,999, and shipped bullion from Nipissing and custom ore of an estimated net value of $322,175. Favourable results were obtained on vein 490 below the 4th level, where three veins were discovered carrying ore assaying from 500 to 1200 oz. The annual report of McKinley-Darragh also showed a decrease in ore reserves, which were reduced from 2,132,820 oz. to 1,871,280 oz. The net profits were $236,656, and the surplus $280,299. The Seneca Superior, after paying back to shareholders twice its capitalization, was closed down on account of the exhaustion of its ore.

PERSONAL.

WILLIAM APLIN has been appointed principal of the Mount Morgan Technical College, Queensland.

G. W. BERTILSON and L. S. HEILIG passed through London to Kasai, in the Belgian Congo.

GEORGE H. BLAKEMORE has returned to Sydney on the conclusion of his trip to England and America.

R. S. BOTSFORD has returned to Petrograd from the Lena goldfields.

THOMAS BREAKELL has left England for Venezuela, and expects to be away until October.

R. GILMAN BROWN and DEANE P. MITCHELL have left for Russia on their way to the properties of the Irtysh Corporation.

W. L. BROWN, D. E. HOFFMANN, W. N. S. VAN DEVENTER, and N. WAGGONER are in London from the Belgian Congo.

H. M. CARLIN is re-opening tin mines for the Heemskirk Tin Syndicate, near Zeehan, Tasmania.

J. E. CARNE has been appointed head of the New South Wales Geological Survey, and R. H. CAMBAGE takes the position of Under Secretary for Mines; these two positions were held by E. F. PITTMAN, who has recently retired.

PERCY E. O. CARR, manager for the Mazapil Copper Co., Saltillo, Mexico, has succumbed to an attack of typhoid fever. He was one of the few mine managers who kept to their posts throughout the revolutionary troubles.

E. C. CARTER has been appointed manager of the Mount Murphy wolfram mine, Victoria.

W. H. COLLIER has been appointed lecturer on engineering in the Ballarat School of Mines.

LIEUTENANT CHARLES A. BANKS is in France with the 250th Company of the Royal Engineers.

DURWARD COPELAND, metallurgist to the Llallagua company, has returned to Bolivia.

R. DAVEY, general manager of the Bogoslovsk Mining Company, Russia, has been in London.

T. D. DELPRAT has returned to Australia from South Africa. He is on the staff of the Cape Explosives Company.

GEORGE A. DENNY has been examining the Cinderella mine in the east Rand.

JOHN V. N. DORR has shortened the name of his firm to 'The Dorr Company.'

DONALD F. FOSTER left on his return to Sukari in Egypt on May 9.

W. T. HALLIMOND passed through London on his way from Johannesburg to New York.

SIR THOMAS H. HOLLAND has left for India.

F. W. HARBORD was presented with the Bessemer medal at the May meeting of the Iron and Steel Institute.

FRED HELLMANN, general manager for the Chile Copper Co., Chuquicamata, is visiting mining centres in the west of America.

PERCY E. HOPKINS has gone to Kowkash, Ontario, to resume his geological investigations of the new gold deposits.

M. R. HULL, lately with the Anaconda Company, has been appointed chief engineer to the Arizona Copper Company.

J. P. HUTCHINS is in South Russia.

W. J. KING has left for the Jantar mine, Naraguta, Nigeria.

NEWTON B. KNOX is consulting engineer for the Phœnicia tin-wolfram mine, in the province of Coruna, Spain.

A. F. KUEHN is returning from Burma, via the United States, on the conclusion of his examination of the Bawdwin lead-zinc-silver mines.

R. B. LAMB is consulting engineer to the Oatman Southern Mining and Milling Co., and the Pittsburgh Mining and Milling Co., both of Oatman, Arizona.

C. H. MACNUTT, manager of the Burma Corporation's mines, is in Japan recuperating from a serious illness. T. L. MITCHELL is in charge of the mines during his absence.

D. H. MCDOUGALL has been appointed manager of the Dominion Steel Corporation, Nova Scotia.

C. MCLEOD has left Victoria on a tour of inspection of alluvial properties in the East on behalf of the Tongkah Compound Company.

JAMES A. MACTEAR has received a commission as Lieutenant in the Army Ordnance Department, to be inspector of ordnance machinery.

H. F. MARRIOTT is visiting the Rand.

F. W. OLDFIELD, general manager of the Cinco Minas Company, Jalisco, Mexico, is in California on a holiday.

H. R. PLATE has been in London and is now on his way to Cyprus.

FRANK H. PROBERT has been appointed professor of mining in the University of California.

C. W. PURINGTON has been reappointed consulting engineer to the Lena Goldfields.

LOUIS REHFUSS has returned from the Congo State, and has left for Russia to join the geological staff of the Irtysh Corporation.

L. D. RICKETTS has returned to the United States from South America.

GILBERT RIGG is leaving the service of the New Jersey Zinc Co., and is going to Australia.

W. A. RITTMAN has resigned from the United States Bureau of Mines, in order to manufacture petrol by his new cracking process.

W. S. ROBINSON has returned from Australia by way of the United States.

A. W. ROGERS has been appointed Acting Director of the Geological Survey of South Africa, and E. T. MELLOR, Acting Assistant Director.

ARTHUR R. SAWYER is on his way home from the Orange Free State on business for the New Rand company.

R. SAWYER, manager of the Likasi mine of the Union Minière du Haut Katanga, is with the British Forces in German East Africa.

NORMAN STINES is expected back from New York.

SULMAN & PICARD are consulting metallurgists for John Down & Co., Swansea. BEN HOWE is in immediate charge of the works.

G. A. SYMONS has been appointed manager of the Lode Hill tin mines, at Cooktown, Queensland.

MAJOR J. W. TEALE is home on sick leave.

B. B. THAYER, President of the Anaconda Copper Mining Co., returned to the United States by way of Buenos Aires, on the conclusion of his visit to South America.

J. B. TYRRELL sailed from Liverpool on May 2 on his return to Canada.

W. H. VINCENT has joined the staff of Knox, Schlapp & Co., of Melbourne.

L. L. WATERHOUSE, of the Tasmanian Geological Survey, has completed his investigation of the mineral resources of King Island.

D'ARCY WEATHERBE is in Petrograd.

WALTER HARVEY WEED has been appointed managing director of the Crystal Copper Co., owning mines 30 miles east of Butte, Montana.

S. A. WOOKEY, lately on the Hollinger staff, has been appointed manager of the Schumacher mine, Porcupine, Ontario.

METAL MARKETS

COPPER.—The stocks in this country continue to decline and the metal left in warehouse is insufficient to support an active market. Transactions are consequently small in volume, and price movements are produced by comparatively unimportant transactions. Values, of course, are steadily rising. The month of April opened at £115. 5s. for cash and £113 for three months; it closed at about £132 cash and £125 three months. But for the restrictions of the Munitions Department in prohibiting speculative dealings the position might be worse. No doubt the scarcity of freight contributes to the lightness of stocks, but the leading cause is the demand for refined metal. The increasing difficulty of obtaining electrolytic copper and best selected has produced an unusual demand for tough, tending to bring prices of the two qualities more on the same level. The difficulty of securing supplies, it is believed, has been causing the authorities no little concern. Meanwhile producers are well sold ahead, and they are not to be induced to cut their prices. In America electrolytic has risen from 27–29 cents to 28–31, and the premium on spot is increasing. A heavy domestic demand is reported there, in addition to the demand for munitions for various governments. A welcome feature is the fact that Japan has appeared as a seller of quite substantial quantities. There is also a large quantity afloat from Chile and Australia. Electrolytic in this country has been selling at £142–£145, a rise of £10 for the month. There are still substantial orders on the market.

Copper sulphate is quoted at £55. The following were the quotations for copper and brass on May 5: Copper, tough £140 per ton, best selected £141, electrolytic £150, American electrolytic wire-bars £152, solid drawn tubes 19½d. per lb., brazed tubes 19½d., wire 19d., yellow metal 18½d.; brass solid drawn tubes 17½d. per lb., brazed tubes 19½d., rods 17½d., sheets 17½d., wire 17d.

Average prices of cash standard copper: April 1916, £124. 4s.; March 1916, £106. 19s. 10d.; April 1915, £75. 3s. 5d.

TIN.—The market was firm and steady throughout the month of April. The scarcity which was felt during March of spot tin has in some measure been overcome by the warehousing of considerable quantities of metal, resulting in a welcome reduction of the backwardation. Prices early in April stood at £202 for cash and £196 for three months, but the end brought closer margins at £198 cash and £197 three months. It is expected that further tonnage will be stored and a healthier tone given to the market with the establishment of a contango.

The demand for English tin has been lively, resulting in a scarcity and a premium over higher quality grades. A steady business has been doing with tinplate makers, but a falling off in business there is probable. At present 70% of the mills are working, and this is likely to decline to 50%. The selling price of their product, however, shows a handsome profit on the present price of tin.

At one time the Straits price was £4 to £5 above London. This anomaly, however, has disappeared in face of the fact that the Straits production comes chiefly to London, and is being delivered there on standard contracts. Business with Java has become more difficult owing to the fall in the Dutch exchange and to the increasing scarcity of freight. Most of the metal is finding its way to America. Enormous prices are still being realized in New York for spot tin, which is accounted for by the shipping difficulties, and the restrictions imposed by the British government. Considerable business has been put through for Russia and France. The outlook appears to be for firm steady markets without any sensational movements in price.

Average prices of cash standard tin: April 1916, £199. 10s. 0d.; March 1916, £193. 13. 10d.; April 1915, £166. 10s. 0d.

LEAD.—The market has been very inactive, and the turnover quite unimportant. Nevertheless the tendency is firm, and in spite of official action toward reducing quotations, the scarcity of the metal continually tends to drive prices upward. The government has been selling its own imported lead on the open market, and has fortunately succeeded in preventing undue inflation. America is still out of the market as a seller, the continuance of the Mexican troubles depriving her of the supplies of bullion to fill the capacity of her refineries; her production of native lead is all required in her own industries. Arrivals in this country from Australia have been quite substantial, but have gone into immediate consumption. From other sources the import shows a notable falling off. Russian demand is good; several substantial shipments are reported from London. From Spain and America other direct shipments have been made to Archangel and Vladivostok. Most of the Spanish production of course is finding its way to Italy and France.

Average prices of soft foreign lead: April 1916, £34. 7s. 11d.; March 1916, £34. 7s. 7d.; April 1915, £21. 2s. 1d.

SPELTER.—Prices have been rising continuously, and spot metal has commanded as high as £110. On the other hand the American official quotation has been reduced, but this does not reflect the actual conditions, and in any case transport difficulties are so considerable that the markets in America and this country are not influenced simultaneously. American production and consumption are both growing, and an active trade has sprung up in zinc ores to the new country. The demand for high-class qualities for the Allies is urgent and continuous, but the supply is limited.

Average prices of good ordinary brands: April 1916, £94. 1s. 8d.; March 1916, £90. 1s. 8d.; April 1915, £49. 17s. 9d.

ANTIMONY.—This metal being in the hands of the Government, no quotation can be given. The last recorded price was £120 per ton some months ago. Antimony ore is quoted at 10 to 11s. per unit.

QUICKSILVER.—The official price of Spanish quicksilver remains at £16 15s. per flask of 75 lb. In America the shortage of two or three months ago has been relieved, but prices are still comparatively high, $135 per flask being quoted in New York, and $150 in San Francisco.

BISMUTH.—The Government controls the English supply, but releases sufficient for the requirements of medicine manufacture. The price was for a long time 10s. per lb., but it is now 50% higher.

CADMIUM.—8s. per lb.

PLATINUM.—This metal has for some time been controlled by Government, which has fixed the price at 190s. per oz. Johnson, Matthey & Co. act as purchasing agents for the Government. In America the tension is not as acute as it was, and sales are reported at $85 per oz.

NICKEL.—The quotation for nickel continues at £225 per ton, and in America at 45 to 50 cents per lb.

ALUMINIUM.—This metal is still controlled by Government, and the price is nominal. Presumably £150 may be taken as an average price.

IRON.—The Government prices fixed a month ago now control the iron trade, and the restriction of exports make it impossible to do business with neutral countries, and even difficult with Allied countries. The bulk of the neutral and much of the French and Italian business is going to the United States. The control prices areas follow: Middlesbrough pig iron £4. 2s. 6d. per ton, Cumberland hematite £6. 7s. 6d., East Coast hematite £6. 2s. 6d., Staffordshire cold blast £8. 17s. 6d. Spanish iron ore 37s. 6d. delivered.

MANGANESE.—In our editorial pages this week we give an outline of the manganese production of the world, the destinations of the various ores, and the uses to which the metal is put. The modifications in distribution and metallurgical practice caused by the war are also set forth. The market quotation for Indian ores this year's delivery is 2s. 6d. per unit, delivered in England. For Brazilian ores, on similar terms, the quotation is 4s. per unit. The price of 80% ferro-manganese remains at £25 for home delivery, and £35 to £40 for export. In the United States, increased imports of ore from Brazil are gradually relieving the anxiety for future supplies of ferro-manganese, but manufacturers are husbanding their stocks carefully, and refuse tempting offers even at the rate of $400 per ton. Metallic manganese is quoted at Sheffield at 2s. 8d. per lb. 90 to 95% metal carbon-free.

MOLYBDENUM.—Molybdenum is still under Government control, and the price of molybdenite 90% MoS_2 is 105s. per unit. In America the price is $1·40 to $1·50 per lb. 80 to 90% MoS_2. Ferro-molybdenum is quoted at Sheffield at 18s. per lb. 65 to 85% Mo.

TUNGSTEN.—This metal remains under Government control, and the quotation for wolfram and scheelite ores 70% WO_3 is 55s. per unit. High-speed tool-steel is quoted at 2s. 10d. per lb. 14% tungsten, and 3s. 10d. 18% tungsten. Scrap is repurchased at 5d. per lb. for millings and turnings, and 6d. for bar ends. Ferro-tungsten 80–90% low carbon, 6s. 1d. per lb.; tungsten metal powder 96–98%, 6s. 3d. per lb.

CHROMIUM.—Chalas & Sons give the following quotations for chrome ores: New Caledonia ore 53 to 55%, f.o.b., basis price for 50% Cr_2O_3, £1. 16s. per ton, scale 2s. Baluchistan ore 53 to 55%, f.o.b., basis price for 50% Cr_2O_3 £3, scale 2s. No quotation published for Rhodesia chrome ore. Ferro-chrome 4 to 6% carbon £35 per ton, basis 60% chromium, scale 10s. per unit; specially refined 2% maximum carbon, basis 60%, £86 per ton. Metallic chromium, 92 to 99%, 5s. 9d. per lb.

TITANIUM.—Ferro-titanium 23 to 25% Ti, carbonless, 1s. 5d. per lb.; 15 to 18% Ti, 5 to 8% carbon, 6½d. per lb.

VANADIUM.—Ferro-vanadium 15s. per lb. of vanadium contained.

FERRO-SILICON.—Basis 75% Si, £48 per ton; 45 to 50%, £28. 10s. per ton, basis 45% Si, with scale of 7s. 6d. per unit.

COBALT.—96 to 98%, 8s. per lb.

SILVER.—The market for silver during the last month has exhibited the greatest liveliness for over twenty years. In March the quotation was 27d. per standard ounce, and last month we noted a sharp rise to 28½d. Few people were, however, prepared for the phenomenal rise that has been recorded since then. At the time of writing, the quotation is 35d., after having been up to 37d. during the first days of May. Not since the stoppage of purchases under the Sherman Act in the United States and the closing of the Indian Mints for the coinage of silver has the price been so high. The large purchases for England and France and the shortage of supplies from Mexico have combined to make the market very strong.

PRICES OF CHEMICALS. May 6.

		£	s.	d.
Acetic Acid, 40%	per cwt.	3	10	0
,, 60%	,,	5	10	0
,, Glacial	,,	10	0	0
Alum	per ton	12	0	0
Alumina, Sulphate of	,,	14	10	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	30	0	0
,, Chloride of, grey	per cwt.	1	13	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	55	0	0
,, Phosphate of	,,	95	0	0
,, Sulphate of	,,	16	0	0
Arsenic, White	,,	31	10	0
Barium Chloride	,,	30	0	0
,, Carbonate	,,	5	10	0
,, Sulphate	,,	5	10	0
Bisulphide of Carbon	,,	30	0	0
Bleaching Powder, 35% Cl.	,,	17	10	0
Borax	,,	28	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	2	0	0
Copper, Sulphate of	,,	55	0	0
Creosote	per gal.		0	4
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		13	9
Iron, Sulphate of	per ton	3	10	0
Lead, Acetate of, white	,,	105	0	0
,, Chemical Sheet Metal	,,	42	0	0
,, Nitrate of	,,	85	0	0
,, Oxide of, Litharge	,,	45	0	0
,, White	,,	47	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	12	10	0
Oxalic Acid	per lb.		1	9
Phosphoric Acid	,,			11
Potassium Bichromate	,,		2	0
,, Carbonate	per ton	165	0	0
,, Chlorate	per lb.		2	5
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb		9	0
,, Prussiate, Yellow (Ferricyanide)	,,		4	3
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	4
,, Acetate	per ton	75	0	0
,, Bicarbonate	,,	6	10	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	10	0
,, Hydrate, 76%	,,	17	10	0
,, Hyposulphite	,,	16	0	0
,, Nitrate, 95%	,,	18	10	0
,, Phosphate	,,	28	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	12	6
,, Sulphide	,,	28	0	0
Sulphur, Roll	,,	12	0	0
,, Flowers	,,	12	10	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tartaric Acid	per lb.		3	10
Tin Chloride (Tin Crystals)	,,		1	4
Zinc Chloride, solution 100°T.	per ton	32	10	0
Zinc Sulphate	,,	31	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
July 1915	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122
November	753,605	27,408	781,013	3,317,534
December	755,101	26,010	781,111	3,317,949
Year 1915	8,772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063
March	768,714	27,975	796,689	3,384,121
April	728,399	26,273	754,672	3,205,643

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9,468	970	219,864
March	203,575	9,588	917	214,080
April	199,936	9,827	938	210,701

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
July 1915	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229
December	2,410,841	26 5	17 10	8 2	985,361
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
January 1916	2,449,518	26 1	17 10	7 10	962,120
February	2,297,276	26 8	18 4	8 0	924,310

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	313,769	144,034	137,739
March	299,686	335,368	153,770	150,987
April	315,541	—	149,978	—
May	318,898	—	142,123	—
June	322,473	—	135,289	—
July	336,565	—	140,290	—
August	344,493	—	139,364	—
September	321,085	—	135,744	—
October	339,967	—	141,771	—
November	313,160	—	122,138	—
December	331,376	—	158,323	—
Total	3,823,166	967,723	1,706,473	429,305

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
Total, 1915	17,277	1,192,790	1,210,067	5,140,189
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,138	67,970	288,717
March	5,600	88,393	93,993	399,255
April	2,926	87,601	90,527	384,532

Australian Gold Production.

	Victoria.		Queensland.		New South Wales
	1915	1916	1915	1916	1916
	£	£	£	£	£
January	69,900	89,900	43,770	66,700	39,000
February	122,300	76,500	85,850	79,050	30,000
March	142,800	103,600	98,550	76,920	36,000
April	109,300	—	97,320	—	63,000
May	102,900	—	130,470	—	—
June	134,200	—	90,500	—	—
July	154,800	—	88,830	—	—
August	80,300	—	93,050	—	—
September	138,900	—	79,470	—	—
October	111,700	—	91,800	—	—
November	115,300	—	77,780	—	—
December	115,400	—	81,170	—	—
Total	1,397,800	270,000	1,078,560	222,670	169,000

Production of Gold in India.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	186,475
April	191,215	189,197	196,747	192,208
May	190,607	193,031	199,786	—
June	189,322	192,224	197,447	—
July	193,859	195,137	197,056	—
August	193,998	196,560	197,984	—
September	191,642	195,843	195,952	—
October	194,314	198,191	195,531	—
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	754,097

Daily London Metal Prices
in £ per long ton.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard
April	£ s. d.	£	£ s. d	£	£ s. d.
3	115 2 6	136	34 12 6	93	197 15 0
4	115 15 0	136	34 0 0	91	197 12 6
5	117 5 0	136	32 0 0	92	199 5 0
6	116 15 0	135	32 17 6	93	201 5 0
7	117 5 0	134	33 10 0	94	202 2 6
10	118 5 0	134	33 17 6	97	204 15 0
11	119 15 0	135	34 5 0	98	201 17 6
12	122 5 0	136	34 10 0	100	198 5 0
13	124 5 0	136	35 5 0	100	199 7 6
14	125 15 0	137	35 5 0	100	200 5 0
17	127 5 0	137	35 5 0	102	200 15 0
18	127 5 0	138	35 5 0	103	200 5 0
19	130 10 0	139	35 5 0	103	197 17 6
20	131 0 0	140	34 12 6	103	198 12 6
25	131 0 0	140	34 0 0	103	197 17 6
26	132 0 0	141	34 10 0	103	198 7 6
27	132 0 0	142	35 0 0	103	196 12 6
28	132 5 0	143	34 10 0	105	198 2 6
May					
1	133 5 0	145	35 15 0	99	200 5 0
2	134 0 0	145	34 10 0	98	201 2 6
3	135 5 0	150	34 12 6	98	200 2 6
4	137 5 0	150	34 12 6	98	200 2 6
5	137 0 0	152	34 2 6	98	200 17 6
8	139 0 0	154	34 5 0	98	200 12 6
9	139 0 0	155	34 10 0	98	199 12 6
10	140 0 0	156	34 5 0	98	198 12 6

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1915	Mar. 1916	April 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	2,085	2,504	12,628
,, Matte and Precipitate	38,372	1,600	7,980	16,266
,, Metal (unwrought and part wrought)	180,368	9,441	7,464	39,490
Copper and Iron Pyrite	903,401	73,977	105,234	360,182
Tin Concentrate	44,748	3,890	3,546	11,409
,, Metal	38,896	2,434	4,670	10,904
Manganese Ore	377,324	30,476	45,500	132,598
Lead, Pig and Sheet	256,476	16,213	14,723	62,593
Zinc (spelter)	74,520	2,936	2,819	12,398
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	—	750,000	1,509,290

Stocks of Copper.
Reported by Henry R. Merton & Co. Ld. Long tons.

	Feb. 29, 1916	Mar. 31, 1916	April 30, 1916
	Tons	Tons	Tons
Standard Copper in England	4,127	2,093	1,052
Fine Copper in England	734	35	1,601
,, ,, Havre	4,950	3,400	4,570
,, ,, Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*
,, ,, Afloat from Chile	2,300	1,750	3,700
,, ,, ,, from Australia	4,500	4,800	5,000
Total Visible Supply	21,734	17,201	21,046
In other European Ports Estimated	500*	—	—

* As on July 31, 1914, but presumably present stock nil.

Exports of Copper from United States
Reported by United States Customs.

1915	Long tons	1915	Long tons	1916	Long tons
January	28,197	July	16,812	January	21,863
February	12,066	August	16,289	February	20,548
March	29,725	September	14,327	March	24,006
April	20,481	October	26,153	April	—
May	25,785	November	19,396	May	—
June	15,751	December	32,936	June	—
		Total 1915	257,915	Total 1916	66,417

Stocks of Tin.
Reported by A. Strauss & Co. Long tons.

	Feb. 29, 1916	Mar. 31, 1916	April 30, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	747	619	1,804
Ditto, Landing and in Transit	227	1,025	1,054
Other Standard, Spot and Landing	1,607	886	1,005
Straits, Afloat	4,330	4,620	3,858
Australian, Afloat	315	325	384
Banca, on Warrants	—	—	—
Ditto, Afloat	1,540	4,340	4,762
Billiton, Spot	17	17	7
Ditto, Afloat	417	333	217
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,850*	1,105*	1,555*
Afloat for United States	5,808	4,405	3,885
Stock in America	1,308	2,746	2,756
Total Stock	18,166	20,421	21,287

* Including 705 tons on board enemy's ships either captured or lying in neutral ports.

Shipments and Imports of Tin.
Reported by A. Strauss & Co. Long tons.

	Year 1915	Mar. 1916	April 1916	1915 to date
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	2,175	2,475	9,205
Straits to America	31,565	2,500	1,260	10,055
Straits to Continent	11,024	495	950	2,940
Australia to U.K.	2,481	245	245	1,130
U.K., Holland, and Continent to America	14,967	1,060	1,115	3,850
Imports of China Tin into U.K. and America	3,012	35	60	245
Imports of Bolivian Tin into Europe	22,591	1,583	1,730	4,819

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	528
March	247	510	502	418	547
April	141	430	482	444	—
May	144	360	480	357	—
June	121	321	460	373	—
July	140	357	432	455	—
August	201	406	228	438	—
September	196	422	289	442	—
October	256	480	272	511	—
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	1,606

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3,313
March	3,196	3,562	3,839	3,653	3,696
April	3,904	4,066	4,087	3,619	3,177
May	4,277	4,319	4,135	3,823	—
June	3,472	3,993	4,303	4,048	—
July	4,234	4,245	4,582	3,544	—
August	4,454	4,620	3,591	4,046	—
September	4,115	4,379	3,623	3,932	—
October	3,905	4,409	3,908	3,797	—
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46,767	14,502

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
September 13, 1915	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3
October 11	166	£13,620	£82 1 0
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0
December 20	181½	£16,941	£93 6 10
Total, 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18,122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179¼	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5
March 13	182	£19,921	£109 9 2
March 27	190½	£21,437	£112 10 6
April 10	185½	£21,517	£115 19 11
April 25	164	£18,504	£112 16 7

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	May 2 1915	Apr. 1 1916	May 2 1916
Rand:			
Bantjes	10	18	15
Brakpan	52	76	78
Central Mining (£12)	137	130	130
Cinderella	4	7	7
City & Suburban (£4)	47	35	35
City Deep	64	76	78
Consolidated Gold Fields	32	28	28
Consolidated Langlaagte	36	32	32
Consolidated Main Reef	19	19	19
Consolidated Mines Selection (10s)	10	17	17
Crown Mines (10s.)	94	56	54
Daggafontein	6	14	16
D. Roodepoort Deep	17	15	14
East Rand Proprietary	32	17	15
Ferreira Deep	50	37	36
Geduld	27	45	46
Geldenhuis Deep	22	22	22
Gov't Gold Mining Areas	22	34	35
Heriot	62	51	52
Jupiter	7	7	7
Kleinfontein	26	31	29
Knight Central	5	16	15
Knight's Deep	21	22	22
Langlaagte Estate	18	19	20
Luipaard's Vlei	[illegible]	9	9
Main Reef West	[illegible]	9	8
Meyer & Charlton	107	106	107
Modderfontein B	96	119	127
Modder Deep	77	130	126
Modderfontein, New (£4)	289	325	330
Nourse	23	17	16
Rand Mines (5s.)	100	74	66
Randfontein Central	14	13	11
Robinson (£5)	35	20	20
Robinson Deep	26	21	20
Rose Deep	36	27	25
Simmer & Jack	8	7	7
Simmer Deep	1	2	[illegible]
Springs	24	55	53
Van Ryn	61	45	45
Van Ryn Deep	51	62	65
Village Deep	38	27	32
Village Main Reef	31	21	20
Witwatersrand (Knight's)	62	55	55
Witwatersrand Deep	35	26	24
Wolhuter	13	11	11
Rhodesia:			
Cam & Motor	15	11	17
Chartered	12	11	10
Eileen Alannah	9	9	9
Eldorado	15	9	9
Enterprise	[illegible]	4	6
Falcon	11	10	10
Giant	[illegible]	7	7
Globe & Phœnix (5s.)	31	25	23
Lonely Reef	22	25	25
Shamva	37	34	34
Wanderer (5s.)	1	1	1
Willoughby's (10s.)	6	5	5
Others in South Africa:			
De Beers Deferred (£2 10s.)	237	220	210
Glynn's Lydenburg	10	10	10
Jagersfontein	62	67	66
Premier Diamond Defer'd (2s. 6d.)	100	100	100
Sheba (5s.)	4	2	2
Transvaal Gold Mining Estates	39	27	25
West Africa:			
Abbontiakoon (10s.)	[illegible]	7	8
Abosso	9	9	[illegible]
Ashanti (4s.)	16	19	19
Broomassie (10s.)	2	[illegible]	½
Prestea Block A	13	10	10
Taquah	15	19	19
West Australia:			
Associated Gold Mines	5	5	5
Associated Northern Blocks	5	3	3
Bullfinch	6	4	4
Golden Horse-Shoe (£5)	49	39	36
Great Boulder Proprietary (2s.)	15	13	13
Great Boulder Perseverance	2	1	1
Great Fingall	6	2	2
Ivanhoe (£5)	45	45	44
Kalgurli	34	12	12
Sons of Gwalia	15	13	14
Yuanmi	2	2	2

Gold, Silver, cont.	May 2 1915	Apr. 1 1916	May 2 1916
Others in Australasia:			
Blackwater	12	15	15
Consolidated Gold Fields of N.Z.	12	11	11
Mount Boppy	12	15	13
Mount Morgan	49	42	44
Progress	7	5	5
Talisman	24	12	12
Waihi	45	34	34
Waihi Grand Junction	25	19	19
America:			
Alaska Treadwell (£5)	146	130	130
Buena Tierra	13	14	14
Butters Salvador	10	10	10
Camp Bird	6	7	[illegible]
Canadian Mining	9	9	12
Casey Cobalt	12	3	7
El Oro	8	8	10
Esperanza	8	9	12
Frontino & Bolivia	9	10	[illegible]
Kirkland Lake Proprietary	31	20	17
Mexico Mines of El Oro	79	75	80
Oroville Dredging	12	14	16
St. John del Rey	15	15	15
Santa Gertrudis	7	10	12
Tomboy	24	21	23
Tough-Oakes	14	11	10
Russia:			
Lena Goldfields	39	34	32
Orsk Priority	9	17	16
India:			
Champion Reef (2s. 6d.)	12	8	8
Mysore (10s.)	86	77	79
Nundydroog (10s.)	26	27	27
Ooregum (10s.)	25	23	22
COPPER:			
Anaconda (£10)	154	362*	357*
Arizona Copper (5s.)	—	36	36
Cape Copper (£2)	62	62	79
Chillagoe (10s.)	½	½	½
Cordoba (5s.)	3	4	4
Great Cobar (£5)	2	3	3
Hampden Cloncurry	25	41	42
Kyshtim	53	44	45
Messina (5s.)	10	11	11
Mount Elliott (£5)	65	76	[illegible]
Mount Lyell	25	29	29
Rio Tinto (£5)	1240	1240	1240
Sissert	24	21	19
South American Copper (2s.)	14	15	15
Spassky	50	40	39
Tanalyk	52	44	40
Tanganyika	28	39	39
LEAD-ZINC:			
Broken Hill:			
Amalgamated Zinc	23	29	32
British Broken Hill	26	29	27
Broken Hill Proprietary (8s.)	43	65	60
Broken Hill Block 10 (£10)	24	24	24
Broken Hill North	45	48	48
Broken Hill South	151	157	160
Sulphide Corporation (15s.)	20	23	23
Zinc Corporation (10s.)	14	15	14
Asia:			
Burma Corporation	39	34	45
Irtysh Corporation	39	41	39
Russian Mining	21	16	15
Russo-Asiatic	110	104	101
TIN:			
Nigeria:			
Bisichi	8	9	8
Ex-Lands Nigeria (2s.)	1	1½	2
Mongu	10	[illegible]	9
Naraguta	17	18	17
N. Nigeria Bauchi (10s.)	2	3	[illegible]
Rayfield	5	7	6
Ropp (4s.)	17	17	16
Other Countries:			
Aramayo Francke	27	25	26
Briseis	6	5	[illegible]
Cornwall Tailings	15	5	4
Dolcoath	9	9	9
East Pool	9	32	32
Gopeng	30	31	31
Pahang Consolidated (5s.)	8	11	10
Renong Dredging	21	29	30
South Crofty (5s.)	6	12	14
Tekka	[illegible]	57	[illegible]
Tronoh	31	39	42

* Denomination of shares recently changed from £5 to £10.

THE MINING DIGEST

A PRECIS OF MINING TECHNOLOGY, DEVELOPMENT, AND LITERATURE

[*In this department will be found listed the more important articles and miscellaneous publications appearing each month which deal with metal mining and non-ferrous mineralogy, the more significant publications being abstracted or reviewed. Copies of the originals can be obtained through the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.*]

PRODUCTION OF FLUORSPAR IN GREAT BRITAIN.

Number 4 of the 'Special Reports on the Mineral Resources of Great Britain,' published by the Geological Survey, is devoted to fluorspar, giving particulars of its production and uses, and describing the mines and deposits in the various parts of Great Britain. The authors are R. G. Carruthers, R. W. Pocock, D. A. Wray, H. Dewey, and E. C. N. Bromehead.

Some fluorspar is produced in France, Bavaria, Saxony, and Spain, but the bulk of the world's supply comes from Great Britain and the United States, and the last named is the leading consumer. The chief use of the mineral is as a flux in iron and steel metallurgy, particularly in the basic open-hearth furnace. Besides making a more fluid slag, it collects the sulphur and phosphorus from the ore and scrap. Its efficiency in this direction is higher than that of limestone, but it is stated that the proportion that can be used is limited, as its favourable effects do not increase indefinitely as the quantity is increased. It is apt to attack the furnace linings, and another disadvantage is that the phosphorus compounds obtained in the slag are comparatively insoluble, so that the slag is of little value as a fertilizer. Fluorspar is used as a flux in other metallurgical processes, such as brass-founding, in the aluminium bath, and in assaying, and in the production of hydrofluoric acid which is used in the electrolytic refining of lead and other metals. It is used in the manufacture of opalescent glass and enamel ware, and as a binding material for carbon electrodes and emery wheels.

As regards outputs, the production twenty years ago in either the United States or Great Britain was less than 5000 tons, but the figures have since gradually risen until, in the year 1913, 53,000 tons was raised in Great Britain and 107,000 tons in the United States.

MAP SHOWING THE DISTRICTS IN DURHAM WHERE FLUORSPAR IS PRODUCED.

The relative rate of increase was governed to some extent by alterations in the American import duty. Until 1909 English fluorspar was imported duty free, and in this year a tax of \$3 per ton was imposed, practically doubling the price. The result was a fall in the English output. In 1913 the tax was reduced to \$1·50 and the English production then slightly revived. The imposition of the tax in 1909 so greatly increased the price that means had to be sought here to obtain a cheaper product, so the old waste dumps were picked over and washed. During the year 1911 nearly 90% of the Derbyshire supplies came from this source, but these resources are now dwindling. The chief producing districts in the United States are in Illinois and Kentucky, and the incidence of railway charges is such that English fluorspar can compete with the American article as far west as Pittsburgh.

In Great Britain the producing centres are in Derbyshire, Durham, Cornwall, and Flint, but only the first two are of commercial importance. In Cornwall the fluorspar is found in metalliferous veins traversing Devonian rocks. In Derbyshire, Flint, and Durham it is found in galena and galena-blende lodes traversing rocks of Carboniferous age, in the first two Carboniferous limestone and in the last named chiefly the Yoredale grits and shales. In Derbyshire the fluorspar is associated with barite and in Durham with silica. The presence of silica is not disadvantageous in the American trade. In Flint the fluorspar is so finely distributed and associated with so many other gangue minerals that it cannot be collected commercially. The mining of fluorspar in Derbyshire and Durham is an adjunct to lead mining. In Durham the chief producing centre is near the head of Weardale, and the yield comes mostly from the mines of the Weardale Lead Company, other owners of properties being George G. Blackwell, Sons & Co., Hird, Waistell & Co., and the Weardale Steel, Coal, & Coke Company. The chief mines are the Sedling, Boltsburn, Stotfield Burn, Stanhope Burn, and Crawley, belonging to the Weardale Lead Co., the Barbary belonging to Blackwells, Park Burn Heights belonging to Hird, Waistell & Co., and the Hope Level and Crawley belonging to the Weardale Steel Co. There are mines also, over the borders of Northumberland and Cumberland, of which the Rotherhope at Alston belonging to the Vieille Montagne Zinc Co. is a small producer. At all these mines three grades of commercial products are obtained, the handpicked 'lump,' and 'gravel' and 'sand' from the jigs. The lump, of course, is the cleanest and best quality on the market.

Derbyshire is the oldest and best known centre in England for the production of fluorspar, where the mineral is found filling veins and other cavities in the Carboniferous limestone. Usually it is confined to the uppermost 300 or 400 ft. of the formation, so that the producing mines are along the margin of the limestone massif, especially the eastern margin. Below this depth the mineral is replaced by barite and calcite. Quartz is very rarely found in the veins. All the mines were originally worked for lead. They can be grouped into seven districts: Castleton, Bradwell, Eyam, Calver, Matlock, Ashover, and Crich. Castleton is renowned for the ancient Odin and 'Blue John' mines, producing the variety of fluorspar prized by makers of ornaments. Eight other mines are also producing, and many others besides are known to contain fluorspar veins. It is believed that very extensive amounts of the mineral are accessible. As an example of the method of working, we may quote the Grove Syndicate's mine at Calver, four miles north of Bakewell. Here the lode varies in width from 2 to 30 ft., with an average of about 8 ft., and it is filled with galena and fluorspar, which are mined together. After hand-picking, the ore is broken and then passed through Krom rolls. By means of screens and hydraulic classifiers the crushed ore is separated into four products, the three coarse being treated in jigs and the fine on vanners. The spar from the jigs is classed as gravel, and that from the vanners as sand. The output of ore, galena, and fluorspar is about 100 tons per week.

In Cornwall fluorspar is found in the killas or Devonian shales and is usually associated with copper minerals. Where the veins are in granite, fluorspar disappears with the copper minerals, and cassiterite and wolfram are found instead. The largest deposit worked recently was found in the Hingston Downs mine near Callington, belonging to the Clitters United Mines, Ltd., where in 1906 a vein of spar 20 ft. wide was struck. Fluorspar has also been found in the districts of St. Agnes, Lostwithiel, Redruth, and Camborne, not at any mine at present working, but on the dumps.

British fluorspar deposits have not been the subject of much literature. The most notable paper was entitled 'The Fluorspar Deposits of Derbyshire,' by C. B. Wedd and G. Cooper Drabble, published in the *Transactions* of the Institution of Mining Engineers for 1908.

AUTOMATIC ELECTRIC HOISTS.

One of the particular advantages of electric winding is that the motor can be controlled automatically. Under certain well defined circumstances the hoists can be started and stopped automatically without any assistance in starting and discharging. In the *Bulletin* of the American Institute of Mining Engineers for March, H. Kenyon Burch and M. A. Whiting describe a hoist of this kind used for raising ore at the Inspiration copper mine, Arizona. The hoisting problem here is simple, for all the ore is raised from one level. Drills, timbers, supplies, and waste are handled through a drift opening, and separate hoists are provided for the men. Moreover the depth and rope speed are not great, the depth being 630 ft. from the loading pockets to the discharge, so that only a moderate retardation effect is required. The average amount of ore raised is 10,000 tons per working day of 14 hours, with a maximum of 14,000 tons. Two vertical shafts have been sunk a short distance apart, known as the East and West respectively, each lined with concrete, and with three compartments. Two compartments of each shaft are occupied by balanced hoists, known as the North and South respectively. The third compartment of one shaft contains a double-deck cage for raising and lowering the men, and the counterbalance of this cage is in the third compartment of the other shaft, which also accommodates air pipes, electric cables, etc. The skips have a capacity of 12½ tons each. The electric hoists employed are of the Nordberg type. No. 2 hoist operates the skips in the East shaft, which is nearest to the power house, and No. 1 hoist operates the West shaft, which is farther away. The ropes from No. 1 hoist pass up above No. 2 hoist, over idler sheaves on the upper deck of the East headframe, and then over sheaves on the West headframe. The two hoists are of the same design, consisting of one fixed and one clutched drum, each 10 ft. diameter by 65 in. face, grooved for 1000 ft. of $1\frac{3}{4}$ in. rope in one layer. The brakes and clutches are air-operated, with oil cataracts and floating levers, and the automatic control system is so designed that the brake engines can be of practically standard type. Each hoist is driven by a 580 h.p. direct current shunt-wound motor, at 575 volts and 264 r.p.m., through a flexible coupling and Falk gear. Power is supplied by a 750 r.p.m. fly-wheel motor-generator set, consisting of one 850 h.p. 2300 volt 25 cycle induction motor, two 500 k.w. 575 volt generators, one 20 k.w. 125 volt exciter, and a 19,700 lb. 112 in. diameter steel-plate fly-wheel. Each hoist motor is connected separately to one of the generators, and is controlled by varying the field of its generator. The fly-wheel is not necessary to the control or automatic operation of the hoists, its function being to eliminate peak-loads from the power system. The control for equalization of the demand for power follows standard lines, using a liquid slip-regulator for varying the speed of the fly-wheel set, by varying the resistance in the secondary circuit of the induction motor.

Before beginning the automatic cycle of operations, it is necessary that each hoist shall be clutched-in for the loading level, with one skip in each shaft resting on the chairs below its loading chute. It does not matter which skips are on the chairs, provided the driver obtains a 'release' of skips in both shafts before starting the automatic operation. He then introduces the automatic control by closing two small control switches and locking-in two levers. This does not of itself start the automatic operation, and the hoists may be left standing in this manner as long as is necessary. To start the automatic operation, a master controller is thrown to the automatic running position, and it is left there as long as automatic hoisting continues.

The cycle of operations may be described, with No. 1 hoist starting to raise the skip in the southern compartment of the West shaft. The closing of the master controller energizes the small pilot motor, which moves No. 1 hoist controller gradually to the full-speed position in one direction. As No. 1 controller starts away from the off position, it simultaneously energizes No. 1 generator field and actuates a pilot device which releases the brakes in No. 1 hoist. As the controller moves farther forward toward the full-speed position, it gradually increases the generator voltage, thereby accelerating the hoist to full speed. Toward the end of its trip, the travel of No. 1 hoist actuates a pilot motor, which moves No. 2 hoist controller gradually to the full-speed position in one direction, thereby accelerating No. 2 hoist in a similar manner to hoist its north skip in the East shaft. Shortly before its skip enters the 'dumping horns,' which discharge the ore, the travel of No. 1 hoist, by means of cams, one of which is geared to each drum, moves No. 1 controller gradually toward the off position. This gradually decreases the voltage of No. 1 generator, thereby retarding No. 1 hoist. Just as its north skip is about to land on the chairs, No. 1 controller comes into the off position, thus completing the retardation and automatically applying the brakes. No. 1 hoist stands at rest while No. 2 is hoisting its north skip. Toward the end of its trip, No. 2 hoist energizes the pilot motor for No. 1 controller, so as to start No. 1 hoist in the opposite direction, that is, to hoist its north skip. No. 2 hoist comes to rest in the manner described for No. 1, and rests while No. 1 is hoisting its north skip. Toward the end of its trip, No. 1 hoist energizes the pilot control to start No. 2 in the opposite direction, that is, to hoist its south skip. The sequence continues in this manner until such time as it is stopped by the operator. A loading system is used underground by means of which the skips are automatically filled with a predetermined weight of ore. The reduction of labour at the foot of the shaft thus obtained contributes to the decrease of cost. If desired to operate the hoists more rapidly, a control switch may be used, causing each hoist to be started earlier in the trip of the other hoist, thus overlapping to a greater extent the trips of the two. Variations in working and other details of the conditions are discussed in the paper.

GOLD AND SILVER IN SOUTH AMERICA.

The mineral resources of South America are attracting considerable attention nowadays in the United States, and the geology and ore occurrences of the continent are being keenly studied. The gold and silver deposits were described by Waldemar Lindgren in a paper presented at the Pan-American Scientific Congress held at Washington in January. This paper is printed in the April *Bulletin* of the American Institute of Mining Engineers, and we quote herewith some parts of the descriptions. Mr. Lindgren in his introduction describes the general geology of the North and South American continents, showing that the eastern portions of the two continents are composed of sedimentary deposits that have lain undisturbed for geological ages, with here and there exposures of Pre-Cambrian rocks laid bare by erosion. The western sides are composed of the high land, mountains and plateaus, forming the Cordilleras extending from Alaska to Tierra del Fuego, that were formed by the folding and uplift through the Cretaceous and early Tertiary ages, accompanied by lava flows. The ore deposits containing gold and silver can be divided into two classes according to these two geological conditions. In the middle and eastern parts of North America the gold and silver deposits are deep-seated, and are found in the exposed Pre-Cambrian rocks at such places as Black Hills, Dakota, Porcupine and Cobalt, Ontario, and in the Southern Appalachian States. In South America similar occurrences are found in Venezuela, the Guianas, Brazil, and Uruguay. As a contrast the Cordilleran ore deposits were formed in late Mesozoic and Tertiary times, by the rising magmatic waters accompanying the lava flows at the time of crumpling and orogeny. In North America they are found in the Rocky Mountains and the Sierras, and in South America through Colombia, Ecuador, Peru, Bolivia, and Chile, to Tierra del Fuego.

In describing in detail the gold and silver deposits of the various states of South America, Mr. Lindgren divides the deposits into early and later deposits. As already mentioned the early deposits are found in Venezuela, Guiana, Brazil, Uruguay, and Argentina. Except in the Guianas they do not form continuous belts, but rather a series of scattered occurrences separated by barren ground or by younger trangressing fluviatile or marine deposits. South of the latitude of Buenos Aires the deposits, if existing, are covered by the Tertiary Pampas formation or by lavas of the same age. The northeastern region extends 650 miles from the Yuruari basin in eastern Venezuela to the border between French Guiana and Brazil. The occurrences worked are mostly placers, to the formation of which the conditions are very favourable; but quartz veins or mineralized dikes have also been exploited. The best example of the veins is furnished by the great Callao mine in Venezuela, which, during its life of 30 years (1865–1895), is said to have yielded £6,000,000 in gold. Active exploitation of the placers and some veins is going on in the three Guianas at present, the French colony yielding the greatest amount. The primary veins from which the placers have been derived are contained in Pre-Cambrian schists, diorites, diabases, granites, and granite porphyries. The gold belt seems to continue to the southeast beyond the boundaries indicated, for it is reported that gold occurs in the provinces of Para, Maranhao, and Ceara, in Brazil, beyond the delta of the Amazon River. To the south follows a broad, barren interval until we come to the gold deposits of Southern Brazil, in the states of Bahia, Minas Geraes, Sao Paulo, Parana, and Rio Grande do Sul. Of these the state of Minas Geraes is by far the most important. Even in the far western part of Brazil, at Cuyaba in Matto Grosso, occur placers said to be derived from older deposits similar to those of Minas Geraes. The deposits are quartz veins of a deep-seated type, allied in places to pegmatite dikes. They occur in part in Archean schists, gneisses, and granites, but most of them are found in a thick sedimentary series of schists and quartzite, which is older than the Cambrian but overlies the Archean. This series contains no intrusives, except some pegmatite dikes, and the Brazilian veins are in this respect markedly different from most other Pre-Cambrian occurrences. It is believed that igneous intrusions took place in the rocks underlying the Pre-Cambrian sediments and that only pegmatitic dikes and quartz veins reached up into the covering series. Similar geological conditions prevail in Rio Grande do Sul, beyond which the gold-bearing region continues into Uruguay, where the most southerly mines are found near Cuñapirú. The most southerly representatives of this older class of gold deposits appear in the Sierras of the Pampas, for instance in that extending from San Luis to Cordova in Argentina. The old crystalline schists, granites, and pegmatites here emerge from under the Pampas formation and the Permo-Triassic beds, and contain deposits of tungsten, gold, and silver, but the latter two metals do not count in quantities sufficient for economic mining. While it is possible that some deposits of this kind occur in the Pre-Cambrian of the Andean region, which is exposed in Colombia and in the northernmost provinces of Argentina, it is improbable that they contribute perceptibly to the total production.

Mr. Lindgren then proceeds to describe the countries where the later deposits are found. Colombia yields annually about £600,000 to £800,000 of gold, and the production is probably capable of considerable expansion. The deposits are found mainly in the western and central ranges, which do not continue northward into Panama, but bend eastward toward Venezuela. The eastern range, in which the city of Bogota is situated, appears to be lacking in precious-metal deposits. Gravel deposits containing gold and platinum are found along the coast on the Atrato and San Juan rivers. The richest placers, some of which are now being dredged successfully, lie along the drainage trending northward, in the Magdalena, Porce, Cauca, and Nechi rivers. These are deposits of great value, though difficulties of transportation and climate have interfered with their successful exploitation. The majority of the lode mines are in the departments of Antioquia, Cauca, Bolivar, Tolima, and Santander, of which the first two are the most important. The deposits are mostly typical quartz veins, often with crystallized native gold, and more or less pyrite, pyrrhotite, arsenopyrite, chalcopyrite, galena, and blende, occasionally also tellurides. They are closely related to the California type and undoubtedly allied in their genesis to intrusive rocks. Though the deposits usually occur in granite and schists of probable Pre-Cambrian age, porphyries or monzonites of much later date (probably early Tertiary) are usually found close to them. These intrusive rocks have sometimes been described as andesites or rhyolites. Among the deposits there is also another class, the representatives of which yield gold and silver or silver alone, and which occur in undoubted flow rocks, such as andesite and rhyolite. Many of them contain also stibnite, tetrahedrite, pyrargyrite, jamesonite, and stephanite, and are formed under materially different conditions and near the surface. Such mines are those at Marmato and Echandia in Cauca, and those near Manizales on the boundary of Tolima and Antioquia. Colombia must be considered as the most promising gold-bearing region of South America.

Ecuador is apparently not rich in deposits of precious metals. The coast is occupied by Cretaceous and Tertiary sediments, the former including some intrusive rocks. These are adjoined by a zone of igneous flow rocks of Tertiary or recent age, surmounted by volcanic cones, while the main or Eastern Cordillera is built of ancient schists and crystalline rocks. Almost the whole of the production, amounting to a few hundred thousand dollars, comes from the ancient mines at Zaruma near the Peruvian boundary and 53 miles from the coast. These veins are contained in a fine-grained diorite. In the Esmeraldas near the coast and the Colombian boundary there are placer deposits which have not so far been successfully worked; the eastern ranges are also said to contain placers which may be derived from deposits of Pre-Cambrian age.

In Peru there are relatively few gold deposits. Some veins are being worked, and a certain amount of placer gold is obtained from the Montaña region of southern Peru. The annual production of gold is seldom over £100,000. Half comes from the copper of Cerro de Pasco, one-sixth is derived from placers, and one-fourth comes from gold-quartz mines. On the other hand, Peru is the leading silver-producing country in South America, the present annual output being about 9,600,000 oz. Of this again more than one-half is derived from the copper mines of Cerro de Pasco, a small amount from lead bullion, and the remainder from silver or gold-silver deposits. The silver districts are numerous and are mostly in the Western Cordillera in the departments of Cajamarca, Libertad, Ancachs, Huanuco, Junin (Cerro de Pasco), Lima, Huancavelica, and Arequipa. It would seem that the silver production could be considerably increased. Geologically there is a great difference from conditions in Colombia. In Peru and Chile we find along the coast and Central Cordilleras a strong development of Jurassic and particularly Cretaceous sediments, folded and in part overturned toward the east. These Mesozoic sediments contain embedded lava flows of the same age, which, however, do not appear to be of importance as regards mineralization.

The great majority of Peruvian deposits appear to be in close genetic connection with numberless small

intrusive masses of deep-seated dioritic or monzonitic porphyries not connected with the flow rocks. Practically all of the Peruvian deposits are of the intermediate type, formed far below the surface. The Cerro de Pasco deposits occur in or close to a stock of biotite-diorite porphyry. In their upper levels the veins carried probably secondary silver ores of wonderful richness, while in depth they have been found to contain low-grade copper ores, which now form the basis of an industrial enterprise.

Besides the smaller bodies of intrusive porphyries, there are also numerous large intrusive masses or batholiths of granodioritic rocks. Some of these form the central parts of the great ranges, and they may continue for a long distance with a width sometimes reaching 50 miles. Around these also there has been more or less mineralization, but of a more feeble character than attended the intrusion of the porphyries. The time of intrusion is taken to be early Tertiary.

In the gold-bearing region of southeastern Peru, northeast and north of Lake Titicaca, we find different conditions. Here the folded sedimentary rocks are of early Paleozoic age and more or less intruded by porphyries and granodiorites. This is in the regions of Carabaya and Sandia, and the Inambari basin on the Montaña slope. A widespread, though not intense, mineralization has taken place; the primary gold deposits are apparently poor but the placers are widely distributed and numerous; partly successful attempts have been made to mine them. This belt is, in fact, the northern continuation of the great tin-silver-gold belt of the eastern range of Bolivia.

Bolivia produces little gold at the present time, but its placers on the Montaña side have at times yielded largely. They lie on the eastern slope of the great range, east of Lake Titicaca, which counts among its peaks Sorata and Illimani, each over 21,000 ft. in elevation. Celebrated among these were the placers of Tipuani on the eastern slopes of Sorata, which have yielded great amounts of gold since the time of the conquerors. There are many other localities south of this. Other placers have been worked recently on the San Juan river near the Argentine boundary. At the present time only two gold veins are worked, both in the eastern range and said to be of the saddle-reef type enclosed in slates and sandstones. The quartz and free gold are accompanied by pyrrhotite, arsenopyrite, and pyrite. They thus belong to the intermediate type accompanying intrusive rocks. The ore is of low grade.

Bolivia has been a wonderful producer of silver, and Potosí was the greatest silver mine the world has known. The Huanchaca de Bolivia, to the south of Potosí, produced silver and lead to the value of £10,000,000 between the years 1873 and 1888. At present Bolivia yields 2,500,000 to 4,800,000 oz. per year. A large part of this comes as a by-product from the tin mines; another part is derived from the mines near Huanchaca.

The great mineral belt of Bolivia lies in the chain which forms the eastern border of the high plateaus, a region of Paleozoic folded slates with intrusive cores of diorite, granite, and porphyry. Volcanoes and lava flows are generally absent. In this range there has been produced a widespread mineralization, in part of gold but more characteristically of the peculiar type of Bolivian tin veins, carrying both silver and tin. All these deposits, extending from the Peruvian boundary almost to the Argentina border, are of the deep-seated type connected with intrusive rocks. In general, these are porphyritic and may be designated as quartz porphyry or granitic porphyry. Interesting changes are observed in depth. Just as the Cerro de Pasco silver veins turned into low-grade copper veins in depth, so the rich silver veins of Potosí are shown to have been transformed into pyritic tin-bearing veins.

The republic of Chile has made little effort to keep account of its mineral deposits. The narrow strip of coast occupied by the republic is in few places more than 150 miles wide, but extends from the 18th to the 56th degrees of south latitude. From latitude 20° to 36°, a distance of 1200 miles, this part of the Pacific slope is mineralized in a complex way, while the remaining distance to Cape Horn contains extremely few gold and silver deposits.

The great resources in copper which have lately been developed in Chile as a rule contain little or nothing of the precious metals. Chile has never yielded very large amounts of gold. At the present time the production appears to be diminishing, and does not exceed a hundred thousand pounds per year. The silver production is a little more valuable, but scarcely reaches 960,000 oz. per year. At no time has the silver figures reached those of Bolivia and Peru, although the rich deposits of the northern coast during a short period in the 19th century made Chile prominent among silver-producing countries. The present moribund condition of the industry appears strange when we consider the almost continuous chain of mining districts extending over a distance of 1200 miles. We may refer readers to E. David Pope's article on Gold Mining in Chile published in this Magazine for July 1915.

The northern half of Chile shows in general a geological structure similar to that of the Western Cordillera of Peru. The Jurassic and Cretaceous formations are strongly developed with contemporaneous lava flows of great volume. Into these are intruded granite porphyries and diorite porphyries in smaller stocks, as well as many batholithic masses of granodioritic rocks. Both of these kinds of intrusions have brought mineral deposits. There are finally heavy masses of late Tertiary lava flows, and in these we find a few representatives of the type of precious-metal veins which were formed near the surface. The great majority of deposits are associated with intrusive rocks, and many of these carry tourmaline with copper and gold, indicating that they were formed under conditions of high temperature.

Some gold-bearing veins are found in rhyolite and allied flow rocks, for instance, at Guanaco, southeast of Antofagasta, probably also at Sierra Overa, southeast of Taltal, and at Andacollo, southwest of Coquimbo. Other veins carrying both silver and gold occur, in andesite flows, in part tufaceous, for instance at Batuco and Cerro Blanco. All veins of this type seem to have a tendency to play out at a depth of a few hundred feet. Much more numerous are the gold quartz veins connected with intrusives, such as granites and quartz diorites. We find them at Canutillo, north of Taltal, in diorite intrusive in Cretaceous limestone. Others are found associated with tourmaline and copper ores at Remolinos in Atacama, at Tamaya and La Higuera in Coquimbo, and at Las Condes in Santiago. Another gold belt extends from Coquimbo down to Santiago, and to Roncagua and Talca, south of that city. These quartz veins occur mostly in granite near the contact of schist.

While silver is sometimes associated with gold, the richest silver mines of Chile, which yielded great amounts of the metal in the 19th century, occur as a rule separate in Mesozoic limestone, intruded by or interbedded with greenstones of various kinds. They are characterized by extremely rich ore and antimonial and arsenical silver minerals; some of them also contain silver amalgam. Their genesis is doubtful. The gangue is mainly calcite. In depth these veins also are disappointing and the silver production of Chile is now only a fraction of what it was when these mines were in bonanza. Among these celebrated districts, mainly situated along the coast, are Huantajaya and Challacollo near Iquique, Chanarcillo (50 miles south of Copiapó), and finally a group of districts including Arqueros and Condoriaco (100 miles south of Copiapó). The great low-grade copper deposits, such as Braden and Chuquicamata, appear to contain little of the precious metals.

In remarkable contrast to the northern half, so rich in precious-metal deposits, the southern part of Chile appears to be remarkably poor in mineral deposits. Scarcely any mines are reported from this region except an auriferous vein worked by the Spaniards near Valdivia, and some auriferous beach sands along the coast, for instance on Chiloe island. Not until we reach the Straits of Magellan are there any producing deposits. At Punta Arenas on these straits and on the eastern side of the Andes there are gold-bearing gravels rich enough to justify dredging. Similar placers are found on the south side of the Straits in Tierra del Fuego. About 1902 a dozen dredges were erected here and for a number of years these gravels have contributed largely to the gold production of Chile, yielding annually up to £120,000. The production has decreased materially during the last few years, owing, it is said, to difficulties in dredging the bouldery deposits.

The difference in mineralization is intimately connected with a great change in topographical and geological conditions between the north and south portions. From latitude 42° down to Cape Horn the Cordillera is invaded by the ocean and by ice. Its westerly margin is cut up into an intricate system of fjords and its summits are covered with ice fields. A huge batholith of granitic and dioritic rocks occupies the whole western range, probably from Puerto Montt to the tip of the continent. On the east side the ice fields often cover its margins. On the west side the adjoining sedimentary rocks are largely submerged, but on Wellington and Chiloe islands these western sedimentaries begin to appear as metamorphosed schists of uncertain age. All along the eastern side the batholith is intruded in Mesozoic (Cretaceous and Jurassic) rocks. Along the eastern edge of the latter we find again front ranges of granitic laccoliths, such as Cerro Payne, Cerro Balmaceda, etc., most of them consisting of granitic rocks. There is little doubt that the gold placers of Punta Arenas have derived their metal from the mineralization along the eastern side of the great Chilean batholith. It would be strange if this batholith should not be accompanied by mineral deposits. That no such have been found may in part be accounted for by the extensive present and former glaciation which would destroy most placer deposits and to the fact that the region is extremely inhospitable. It would not be surprising if scientific prospecting along the borders of this batholith should lead to the discovery of gold-bearing deposits.

The Argentine production of gold and silver is very small, and the country has never yielded large amounts of these metals. The Sierras of the Pampas, like that extending from San Luis to Cordova, contain a feeble Pre-Cambrian or early Cambrian mineralization, but these quartz veins appear to be poor in gold and silver. In the same vicinity there is also evidence of a much later development of gold deposits, perhaps connected with the effusion of Tertiary andesitic lavas, but these veins, which have the character of crushed or sheeted zones, are also poor in gold. The whole eastern slope of the Andes from the Bolivian plateau to the latitude of Santiago de Chile shows a relatively feeble mineralization. Gold, silver, and copper prospects are rather abundant, but at very few places has serious work been undertaken. The most important deposit located at Famatina is a copper-bearing vein with sulpharsenides and antimonides of copper and little gold and silver.

No lode deposits are reported south of Mendoza, except on the head waters of Neuquen river, at about the latitude of Concepcion in Chile, where there is a mining district of gold-bearing quartz veins in granite of uncertain age. Considerable work has been done on these, but the expected production does not seem to have been realized. The ore is apparently of low grade. The only other precious-metal deposits reported from the eastern slope of the Andes in Patagonia are placers of doubtful value on the headwaters of Chubut, Gallegos, and other streams. Placers and some lode mines have been taken up at various places on the Argentine Tierra del Fuego, but little information is available as to their values. As observed above, the Mesozoic beds of the Patagonian Cordillera and eastern Cordillera are intruded by laccolithic and batholithic masses of granitic rocks, and careful prospecting might well yield favourable results. The glaciation probably would have destroyed any placers which may have existed in this region, and this guide for the prospector is, therefore, generally lacking.

THE RAND CONGLOMERATES.

The paper by Dr. E. T. Mellor on the Conglomerates of the Witwatersrand, read before the Institution of Mining and Metallurgy in February, and quoted in our March issue, has aroused some considered discussion. The Institution's *Bulletin* for April contains contributions by David Draper and J. B. Tyrrell, the former an old student of Rand geology and the latter an experienced placer geologist. As far as the discussion on Dr. Mellor's paper has gone, both in the Institution's publications and elsewhere, it appears to be generally accepted that his paper has served to weaken the theory of the deposition of gold from ascending solutions, but there is some hesitation in accepting his particular theory of placer formation.

Mr. Draper argues that, with regard to the deltaic deposition of the conglomerates, Dr. Mellor dealt with the Johannesburg area extending from the Nigel to Randfontein as an isolated occurrence, and made no mention of the great Witwatersrand system of South Africa as a whole. It should be remembered that Witwatersrand beds outcrop over great areas in the districts of Heidelberg, Klerksdorp, Venterskroon, and Vredefort in the Orange Free State, as well as in Zululand, and that the Lower Witwatersrand beds are especially well developed over this great tract of country. The Johannesburg area only differs from the others in the occurrence of the Main Reef series and its high gold value; but this is hardly sufficient to warrant the supposition that it was deposited in a manner different from other portions of the same series, unless Dr. Mellor is prepared to maintain that each occurrence of Witwatersrand beds has been laid down in the same manner, though in a separate delta. If all the system is included, then his delta extended practically half across the southern portion of the African continent, and, as an identical series of rocks occurs widely distributed in Brazil, the South American continent must be included.

The persistence of identical beds of distinctive character is not confined to the Witwatersrand beds near Johannesburg. For instance, the remarkable regularity of the ripple-marked and felspar beds in the Johannesburg, Heidelberg, Klerksdorp, and Vredefort areas led Mr. Draper to individualize them and to name them as markers over fifteen years ago. In the same manner several members of the conglomerate beds themselves can be distinguished in the districts mentioned above, but no actual Main Reef, carrying gold in payable quantities, has been found beyond the limits of the Johannesburg area. This question of gold content is the only important difference between the last mentioned and the other areas. The remarkable persistence of some members of the Witwatersrand series, together with the abrupt changes from fine-grained argillaceous rocks to coarse sandstones, as in the case of the ripple-marked beds, and to felspathic rocks, as in the case of the felspar beds, must be attributed to other than deltaic action. These abrupt changes are even more noticeable in the Government and Promise series.

Dr. Mellor's section shows conformity of the entire Witwatersrand series from the basement conglomerates to the Upper Elsburg beds. This is in conflict with the views of many Rand geologists, who recognize unconformity at the base of the Elsburg or between the Elsburg and Kimberley series. In order to obtain a placer deposit the destruction of some pre-existing series of rocks is essential. No such series is known to exist, and Dr. Mellor shows the Witwatersrand beds lying directly on granite. It is evident that if this is the case, the so-called placer deposits of the Upper Witwatersrand could not possibly have been derived from the destruction of the lower member of the system, and the absence of pebbles of granitic origin, or of quantities of felspar in the quartzite, precludes any idea of their having been derived from the destruction of the granite underlying the Rand. Nor would the destruction of either the Lower Witwatersrand beds or the granite have produced the vast quantities of quartz that go to make up the conglomerate beds. If then the placers are not of local derivation, one is prompted to ask how so soft a metal as gold could have survived the attrition caused by a long journey and the buffeting of the conglomerate pebbles, and whether the gold could be transported as metal in suspension by aqueous means for any considerable distance. If the gold has been transported in its metallic form one would expect the coarser gravels to contain larger particles than the finer sediments, but this is not the case, for the fineness of the Rand gold is a characteristic feature.

Dr. Mellor certainly disposes of the infiltration theory, but there is still De Launay's theory to consider as a possible explanation of the occurrence of gold in the Witwatersrand beds. De Launay ascribed its origin to chemical reaction on a gold-bearing solution in operation contemporaneously with the deposition of the conglomerate beds themselves. By this means nuggets or crystalline gold could be formed; local enrichment where conditions were favourable would be a marked feature. No special reagents are necessary, for there are a multitude of substances both mineral and organic that could bring about the necessary precipitation. Dr. Mellor shows how this has occurred in recent times by what he calls insignificant agencies, and surely he will not deny Nature the power of producing the same results on a large scale. Cosmo Newberry succeeded in forming nuggets of varying size in his laboratory. Mr. Draper's contention is that nearly all so-called alluvial gold deposits are formed in this manner. The isolated gold-bearing gravel of Hibernia Creek, the angular gold-bearing gravels of the Kantoor and Cyferfontein near Krugersdorp and the nuggety gold of Witpoortje, could not be attributed to the transport of gold suspended in running water. They are instances of the formation of nuggets from auriferous solutions *in situ*. De Launay's paper was published in the Transactions of the Federated Institution of Mining Engineers for 1892.

The contribution to the discussion by J. B. Tyrrell refers to the nature of the gold in Klondike, indicating that the gold has been transported in solution. In the older Pliocene gravels most of the contained gold was in the form of well-rounded particles similar to those in the newer gravels. But in addition there were many pieces which showed beautiful sharp crystalline structure, either in moderately stout forms, or in delicate feathery shapes such as it would be difficult or almost impossible to move without crushing or destroying. In many cases this gold was in the form of thin crystalline films between layers of the schistose bedrock, while, in one instance, a very delicate film of gold was found adhering to the outside of a pebble in the gravel. Such crystals had never been mechanically transported along with sand and gravel by water, but had evidently been formed just where they were found. The gold would seem to have been first dissolved, probably by the action of water on the surrounding dust, and then to have been precipitated from the solution. In no instance did Mr. Tyrrell find any evidence that pyrite took any part in this action, or was precipitated with the gold. Possibly the gold had not been carried any appreciable distance in solution, for the crystals were always found within the narrow limits of the original thin gold-bearing layer of gravel and bedrock, and not in the gravel above it or in the bedrock below it. If the process of solution and precipitation which gave rise to these crystals were carried far enough it is quite conceivable that it might completely destroy the rounded character of the particles of gold usually found in placer deposits, and give rise to forms and characteristics similar to those found in the conglomerates of the Witwatersrand. Further discussion of this phase of the placer theory may be expected.

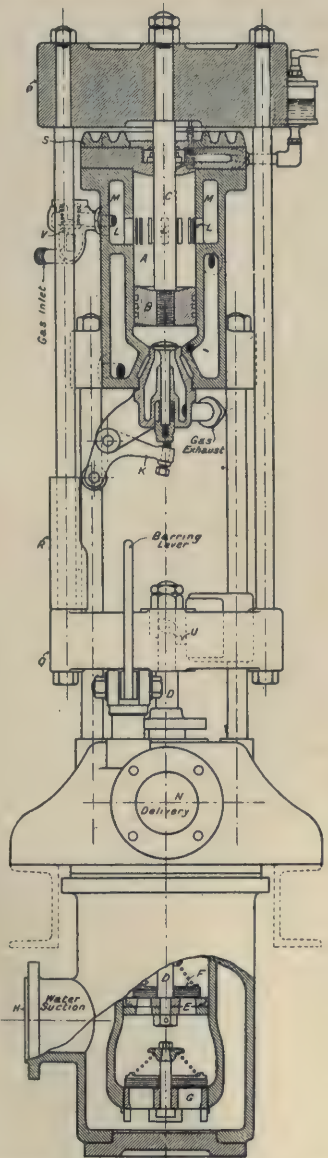
HUMPHREY'S GAS-ENGINE PUMP.

In our issue of January 1910 we gave an account of the internal combustion pump, invented by H. A. Humphrey. In this pump the explosion of a mixture of gas and air takes place in direct contact with the surface of water and forces it up to the delivery. This method has proved efficient in connection with waterworks and similar engineering, but the plant is too bulky for a mine. The inventor has designed a new type in which the gas engine is separate from the pump, and the whole occupies a narrow space. *The Engineer* for April 28 gives a description of this pump. The two parts consist of a two-stroke cycle internal combustion upper end and a single-acting water pumping end below. The combustion cylinder A in the case illustrated is 3 in. in diameter and contains a piston B, from which a rod C passes upward through a packing gland in the end cover to be attached to an external crosshead P. From the latter two rods depend to unite it with a lower crosshead Q. From the centre of the lower crosshead a rod D passes downward through a gland in the top cover of the pump end, and at its lower end this rod carries the pump bucket E with its upwardly opening valve F. A somewhat similar foot valve G closes the end of the pump barrel. In the 3 in. pump the combustion end is supported from the pump end on three pillars. The whole is supported by means of two feet cast on the side of the pump barrel.

In considering the cycle of operations, let us suppose that we have a charge of compressed mixture beneath the piston B, and that this is ignited. The explosion drives the piston upward and with it all its connections, that is to say, the rod C, the weight P, the two side rods, the crosshead Q, the rod D, and the pump bucket. The movement of the latter carries with it the water above the bucket and creates a suction beneath, which draws in fresh water below the bucket through the foot valve. Thus on the up stroke, suction and delivery occur simultaneously. The down stroke is brought about by the weight of all the parts mentioned above, and during the stroke all that occurs in the water end is the passage of the water through the pump bucket valve from the lower to the upper side of the pump piston.

The manner in which the charge is introduced beneath the piston B is as follows: Surrounding the power cylinder is a jacket divided into two portions by a horizontal diaphragm wall. The lower portion constitutes a water jacket. The upper portion M is a mixture chamber, to which gas and air are admitted through the automatic non-return valve V. On the down stroke of the piston, mixture is drawn in from this chamber through the ports L to the space above the piston. On the up stroke this mixture is re-compressed back into the chamber M until the top edge of the piston cuts off the ports. A certain amount of mixture is now trapped above the piston and forms a cushion having a maximum pressure of, say, 10 lb., which brings the piston and its connections smoothly to rest. This, however, does not occur until the piston has risen so far that its lower edge has opened the ports L. Mixture from the chamber M is thus free to flow into the cylinder beneath the piston. On the down stroke this mixture is compressed to 200 lb. This compression serves as a cushion to bring the piston, etc., quietly to rest at the foot of the stroke.

The removal of the products of combustion is effected through the central exhaust valve at the foot of the cylinder. This valve is operated by a bell-crank lever K, pivoted to the foot of the cylinder casting, and carrying a roller which is arranged to come in the way of a cam block R on one of the side rods. The exhaust valve opens on the up stroke a little before the bottom edge of the piston uncovers the ports L. The larger proportion of the exhaust is thus discharged before the incoming fresh charge drives the remainder out. The exhaust valve closes on the down stroke at



Vertical Section of Humphrey's Pump.

the same point as it opened on the up stroke, that is to say, it shuts a little after the piston has cut off the ports L.

It will be seen that all the useful work is done on the up stroke during the expansion of the gases. On the down stroke the work done is spent against friction, including that of the water passing through the valve F, and in compressing the fresh charge. The former item is very small, so that nearly the whole of the potential energy in the raised mass plus the pressure energy in the cushion above the piston is transferred to the charge. A feature of the design lies in the fact that no side thrust is generated at any point by the piston against the cylinder walls as in an ordinary crank pump. The movement is a pure reciprocation, and there is an entire absence of rotating parts except for the exhaust valve bell-crank lever.

The fact that all the useful work is done on the up stroke has an important practical result in that it means that the pump bucket rod D is always in tension. Thus the water end can be lowered down a well, while the combustion end is fixed over the mouth, the rod D being suitably extended; but the diameter of this rod need not simultaneously be increased, because it is not called upon to act as a strut at any time during the cycle of operations.

At present, two sizes are being made, having power cylinders 3 and 6 in. diameter respectively. The 3 in. pump can lift 9200 gallons per hour through 8 ft., or 575 gallons per hour to a height of 172 ft. The 6 in. pump will raise 1500 gallons per hour to a height of 500 ft. The weight of the 3 in. pump is 350 lb., and of the 6 in. pump 1630 lb. The consumption of fuel in the 3 in. pump is 20 cu. ft. of gas or $\frac{5}{8}$ pint of petrol per hour, and in the 6 in. pump from 105 to 120 cu. ft. of gas per hour.

Molybdenite in New South Wales.—*The Australian Mining Standard* for March 2 publishes a short article by E. C. Andrews describing the methods of concentrating molybdenite ore in New South Wales. The methods employed are crude and consist mainly of dry crushing and screening. Water concentration and flotation are employed experimentally at various places. The method depends on the nature and size of the deposit. With small deposits containing flakes of molybdenite in quartz, it is usual to break the ore by hand, either with hammers or rolls, and to recover the larger flakes by hand-picking, and the smaller flakes by sieving, the sieves catching the molybdenite and letting the quartz pass through. At the larger deposits mechanical methods are possible. In this connection the author quotes the practice at Kingsgate, 20 miles east of Glen Innes, and gives particulars of one of the plants. The deposits in this district contain bismuth minerals as well as molybdenite. The plant described has a capacity of 5 tons per day. The ore contains 3% of bismuth and molybdenum minerals. It is crushed in a rock-breaker to 1 inch, and is then sent to two sets of rolls which are provided with screens to save the larger flakes of molybdenite. This oversize is returned to the rolls in order to reduce the quartz still further. Underneath the second pair of rolls of shaking screen is fixed. The holes in this shaking screen are about 1/12 in. diameter. The undersize passes to a Wilfley table which serves to save the bismuth. The tailing from the table is stored pending probable improvements in treatment, such as some form of oil concentration. The oversize from the 1/12 in. screen is carried to a third set of rolls where it is crushed to 1/20 in. and screened. Much of the oversize from this process is cleaned by hand-sieving. The first part of the oversize, however, is re-crushed in rolls set close together, and passed over screens of 1/32 in. mesh. The oversize from this varies from 92 to 95% molybdenite. The undersize is a product rich in molybdenite, but considerably below the required 90% standard.

Some small plants have been built in New South Wales with the object of concentrating molybdenite ores wet. These, however, have not treated large tonnages as yet. Of these the plant erected by Charles Poulot at Sydney presents some interesting features. The ore, after fine crushing, is pumped to the top of the building by a sand-pump into a dewatering tank. Thence the water returns to the pump, while the ore drops into a small centrifugal, situated beneath the dewaterer. The centrifugal mixes the pulp with oil fed by drops from a tank. The oiled mixture is lowered into horizontal shaking troughs pierced with holes and discharging into boxes filled with water. The molybdenite floats and is discharged into launders leading by tubes to a screen of 180-mesh, and then dried. The boxes are arranged in four tiers vertically above each other. As soon as a certain amount of pulp has been treated in the upper tier of boxes, taps are opened in these boxes and the material which has sunk to the bottom is led into the horizontal shaking troughs attached to the second tier of boxes and the whole process is here repeated. The same proceeding is followed for Nos. 3 and 4 tiers of boxes.

Production of Hydrogen.—Two papers have been published recently in *Metallurgical and Chemical Engineering* describing modern methods of preparing hydrogen on a commercial scale. In the issue of March 15 there appeared a paper by Captain Edward D. Ardery on 'Hydrogen for Military Purposes,' and in that for April 1, one by H. L. Barnitz on 'The Technical Production of Hydrogen and its Application.'

Hydrogen is extensively applied on an industrial scale nowadays. In warfare it is used for filling Zeppelins and other air-ships and balloons. In metallurgy it is used for reducing tungstic acid, and, in association with oxygen, for fusing tungsten powder, platinum, silica, and other refractory substances. The oxy-hydrogen flame is used in the autogenous welding of many metals, and also for cutting metals as a substitute for sawing. A great number of processes have been employed or proposed for producing hydrogen cheaply. The old way was to treat iron or zinc with sulphuric acid. In the Russo-Japanese war, the Russians used the reaction between caustic soda and aluminium. Subsequently Schuckert employed silicon instead of aluminium, and in France ferro-silicon has been used in the same reaction. Calcium hydride has also been produced, the reaction being the liberation of hydrogen on contact with water. All the above-named processes have proved too expensive, and some are difficult to manage on account of the great heat liberated by the reactions. During the last few years four other processes have been tried and extensively adopted. Two were revivals of old processes, namely, the electrolysis of water, and the dissociation of steam by contact with red hot spongy iron. The third process consists of passing oil vapours through incandescent coke which splits the hydrocarbons into carbon and hydrogen. The fourth process consists of fractionally separating the constituents of water-gas (H, CO, and N) by liquifaction. Hydrogen is usually transported in compressed form in steel cylinders. The two papers contain a great deal of technical information relating to the details of the processes, their relative advantages and disadvantages, and the costs.

Kerogen Shales.—At the meeting of the Institution of Petroleum Technologists held on April 18, E. H. Cunningham Craig read a paper on the origin of kerogen in oil shales. The word 'kerogen' was invented by Professor Crum Brown to denote the substances in Scottish oil-shales from which oil and ammonia are obtained by distillation. Kerogen is found in other deposits such as boghead coal and torbanite, which are midway between coal and oil-shale, and even some coals yield petroleum on distillation, so may be said to contain kerogen. It is commonly supposed that the small bodies of yellow material distributed throughout the boghead coal or oil-shale are the source of the petroleum. Some geologists have considered that these bodies are fossil algæ, and others spores of vascular cryptogams. Mr. Craig differs, and considers that they have been developed since the formation of the deposit, being formed by the absorption and adsorption of petroleum by the argillaceous material of the shales, with an accompanying thickening or inspissation of the petroleum. Mr. Craig describes various occurrences of kerogen shales, and indicates methods of detecting them. The fact that they contain ammonia enables them to compete with the petroleums flowing freely from sands, and they are likely to become of greater importance as years go by.

Liquid Air as an Explosive.—In connection with our editorial article last month on liquid air as an explosive, it is worth mentioning that a lengthy article was published in *Stahl und Eisen* for November 11 and 18 last. This article gives credit for the invention of the cartridge described by us to Kowatsch, a mining engineer, and describes a variation of the method, invented by Schulenberg, whereby the liquid oxygen is absorbed by the cartridge before the latter is placed in the hole. The paper also describes the liquifaction plant. Two points of disadvantage are elaborated in greater detail than in our notice. One refers to the size of the cartridge. Owing to our drawing being cut to make room for it in our page, the correct idea of the length of the cartridge was not given, for the actual cartridge is from 18 to 40 inches long, a size very inconvenient to handle. The other refers to the wide variation in the relative contents of the explosive mixture. Owing to the rapid evaporation of the liquid oxygen, the relative amount of carbonaceous material and oxygen can never be determined. Consequently it may often happen that the amount of oxygen present at the moment of detonation may be insufficient to produce a complete combustion of the carbon to carbonic acid. If the combustion is incomplete, large proportions of carbonic oxide would be formed. This want of dependability as to the nature of the fumes would appear in itself to be a sufficient drawback to warrant the abandonment of this use of liquid oxygen.

Screens for Conical Ball-Mills.—In the *Engineering and Mining Journal* for April 15, Charles Spearman describes the practice at the Tough-Oakes mine, Kirkland Lake district, Ontario, in connection with the Hardinge ball-mill. It was found, by the ordinary practice, that the capacity of the mill was not up to expectations, and many experts were called in to advise. Finally the idea was conceived of a less obstructed discharge, permitting the whole product, oversize and undersize, to pass through a conical screen attached inside the discharge end and revolving with the mill. The effect of this screen is to classify the product, and the oversize is returned to the feed end of the mill by means of a conveyor. By means of this screening device, the horse-power of the machine was reduced from 40 to 35, and the capacity was increased from 90 to 110 tons per day. The device made it possible to raise the level of the load in the mill without the grinding medium being discharged, the actual load being increased from 8500 lb. to 11,500 lb. About 2 tons of accumulations of oversize ore and undersize pebbles are by this means removed every day. It has become possible to use ore in part substitution of pebbles, with the result that the pebble consumption has been reduced from 16 to 3·9 lb. per ton of ore.

TECHNICAL JOURNALS FOR THE MONTH

British.

Colliery Guardian.—*April 7:* Accidents due to Poisonous and Asphyxiating Gases in Mines, Dr. L. G. Irvine, from a paper published in the *Medical Journal of South Africa;* Utilization of Coal-tar Pitch in Coke-Ovens. *April 28:* Fire-damp Detector for Miners' Lamps, T. J. Thomas.

The Engineer.—*April 14:* An Electrically-driven Sinking Pump made by Holden & Brooke, Manchester. *April 21:* Rustless Ferro-Alloys, Leslie Aitchison [continued *April 28*]; British Mining Machinery and the Russian Market, P. Gurewitch. *April 28:* High-lift Electric Pump at a Staffordshire Colliery; New Form of Humphrey Gas-Actuated Pump.

Engineering.—*April 7:* Winding Engines for the Chislet Colliery, Kent, built by Fraser & Chalmers [continued *April 28*]. *April 14:* Hydro-electric Generators for the Rjukan Plant in Norway, used for producing nitric acid from the air by the Birkeland-Eyde process.

Institution of Electrical Engineers. — *April 13:* Present Position of Electricity Supply in the United Kingdom and the Steps to be taken to Improve and Strengthen it.

Iron and Coal Trades Review.—*April 7:* Rise and Development of the Semet-Solvay Coke Ovens, Kotaro Shimomura, reprinted from a pamphlet issued by the company making these ovens. *April 21:* Shaft-signalling at Pelton Colliery, Durham; French Iron and Steel Works in War Time.

Liverpool Engineering Society.—*April 12:* Electric Power in Slate Quarries, G. K. Paton.

Manchester Geological and Mining Society. — *April 11:* Economies in Coal Washing, Sherwood Hunter.

Mining Institute of Scotland.—*April 8:* The Sinking and Equipment of a Circular Shaft, James Nisbet.

North of England Institute of Mining and Mechanical Engineers.—*April 8:* Influence of Incombustible Substances on Coal-Dust Explosives, A. S. Blatchford.

Colonial.

Canadian Mining Institute Bulletin.—*April:* Proceedings of 18th Annual Meeting of the Institute; Imperial Policy and the Mineral Resources of the British Empire, Baliol Scott.

Canadian Mining Journal.—*March 15:* Leaching Chloridized Speiss from Cobalt Silver Ores with Cyanide, R. W. Bridges; Debate in Canadian House of Commons on Proposed War Tax [continued *April 1*]; Mineral Production of Canada in 1915, John McLeish [continued *April 1*]. *April 1:* The Kowkash Gold Area, Ontario, P. E. Hopkins; Sampling and Assaying of Molybdenum Ores, B. C. Lamble.

Mining and Engineering Review (Melbourne).—*February:* Pyrite Smelting, a discussion of R. C. Sticht's paper, abstracted in our issue of January last, J. D. Audley Smith; Does it Pay to Re-open Old Mines? E. M. Weston. *March:* The Flotation Process and Research, W. Shellshear; Wood-burning Gas Producer at Hampden Cloncurry mines, Erle Huntley.

South African Institution of Engineers Journal.—*March:* A Study of Belt Conveyors applied at Mines, A. Robertson and A. McArthur Johnston; A Preheated Blast Cupola, J. A. Parsons.

South African Mining Journal. — *February 26:* Conditions for Manufacture of Calcium Carbide in South Africa; The Karroo Coal Controversy, J. E. Mills Davies. *March 4:* Oil Shales in the Union and the Need for Investigation [continued *March 18*]; Evolution of the McNamara Shot Drill; Debate in the House of Assembly on the State Exploitation of the Far East Rand; Karroo Hydrocarbon Minerals, Stanley Nettleton; A New East Rand Map by W. E. Bleloch and a Geological Report on the property of the Southern Van Ryn Reef Co. by W. T. Hallimond; Future Producers of the Far East Rand—I.: The Rand Klip; Conditions for Manufacture of Cyanamide and Cyanide in South Africa. *March 18:* Future Producers of the Far East Rand—II.: East Rand Mining Estates; Rand Earth Tremors Committee's Report. *March 25:* Producers of the Far East Rand—III.: The Sub-Nigel.

Queensland Government Mining Journal.—*March:* Review of Queensland Mining Industry for 1915, Under Secretary for Mines.

Foreign.

American Institute of Mining Engineers Bulletin.—*April:* The Water Problem at Old Dominion Copper Mine, Arizona, P. G. Beckett; A Combined Hydraulic and Mechanical Classifier, M. G. F. Sohnlein; Gold and Silver Deposits in North and South America, Waldemar Lindgren.

Engineering and Mining Journal.—*March 25:* The Mitchell Caving System of Mining as applied by the Calumet & Arizona Copper Company, R. H. Dickson; Dredging and Hydraulicking during 1915 by the Yukon Gold Co., O. B. Perry; Plan and Flow-sheet of the Washoe Smelter of the Anaconda Co.; The New Granby Zinc Concentrator, Missouri, L. L. Wittich; The New Konomax Drill, E. M. Weston; Self-rotating Hammer-Drill made by the Chicago Pneumatic Tool Co.; Interfacial Tension in Flotation, H. J. Stander; American Smelting & Refining Co.'s Report for 1915. *April 1:* Iron and Copper Mining in Oriente Province, Cuba, J. T. Singewald and B. Le R. Miller; Zinc Production in 1915, revised figures, W. R. Ingalls. *April 8:* Gilman Cut-and-Fill System of Mining employed by the Calumet & Arizona Co., R. H. Dickson; Effect of Borax in Matte Fusion, G. E. Johnson; Rapid Method of Analysis of Lead Ores, L. B. Pringle. *April 15:* The Andrada Gold Dredge in Portuguese East Africa, L. C. de la Marliere; Correcting the Shaft of the Barron Mine, Pachuca, J. E. Smith; The Malm Process Tests in Idaho; The Rate of Slime Settlement, E. E. Free; Conical Mill fitted with Conical Revolving Screen at Discharge, C. Spearman (details are given elsewhere in this issue); Steel's Jig for Gold Dredges.

Far Eastern Review (Shanghai).—*January:* The Pekin Syndicate's Coal Mine in Honan, China. *February:* British North Borneo, G. M. Hanson; The State Railways of Siam.

Iron Age.—*March 9:* Research on Corrosion of Steel, especially in connection with constituents, such as copper, that prevent corrosion, D. M. Buck and J. O. Handy; American Investments in South Africa, P. Farquhar. *March 23:* Determination of Gases in Steel, translated from *Stahl und Eisen*. *March 30:* Mining Manganese Ore in Virginia; A New Form of Optical Pyrometer, I-Rite.

Metallurgical and Chemical Engineering.—*April 1:* Potash from Sea-weed in Southern California, H. L. Glaze; Alkali Deposits of California and Oregon;

Operation of the Blast-Furnace: Slags, J. E Johnson, Jr.; Available Hearth Heat of the Blast-Furnace, A. L. Field; Sources of Error in the Iodometric Determination of Copper, C. E. Smith; Metallurgical Disposal of Flotation Concentrates, R. J. Anderson; Mass Screening with Flat Screens, E. S. Wiard; Determination of Zinc in Retort Residues, W. McA. Johnson. *April 15:* Fixation of Atmospheric Nitrogen before Congress; Ostwald's Process for Producing Nitric Acid from Ammonia; Continuous Decantation in Cyaniding Silver Ores at Pittsburgh-Dolores and Rochester Mines, Nevada; Electrolytic Determination of Copper in Copper Manganese, E. D. Koepping; Burdening the Blast-Furnace, J. E. Johnson.

Mining and Engineering World.—*March 18:* Man Hoist at Inspiration Copper Mine, Arizona. *April 1:* Oatman and the Tom Reed Gold Road Mining District, Arizona, E. A. Ritter; Circular-feed All-screen Mortar-box for Stamp-Mills, E. H. Moyle. *April 8:* Zinc Mines in St. Lawrence County, New York, B. J. Hatmaker; Recent Developments in Gold Mining Districts of Northern Ontario, S. W. Osgood. *April 15:* Geology and Mining Activities of Northern Ontario Mining Fields, A. K. Stewart.

Mining and Scientific Press.—*March 18:* The Bradley-Williams Electrolytic Zinc Process, tried in Rhodesia in 1910, H. A. B. Motherwell; Geology of Tungsten Deposits in America, J. J. Rimmer. *March 25:* The Nevada-Wonder Pipe-Line, J. A. Burgess; Uses of Furnace Slag, Herbert Lang. *April 1:* The Mineral Industry of Chile, Lester W. Strauss; Platinum at the Boss Mine, Nevada, F. A. Crampton. *April 8:* The Selby Lead Smelter, T. A. Rickard; Precipitating Action of Carbonaceous Shale in Cyanide Solution, P. W. Avery; Machinery for Cyaniding Flotation Concentrate, A. E. Drucker.

Journal of Geology.—*February-March:* Studies in Hydrothermal Alteration: the Action of Alkaline Solutions on Felspars and Hornblende, E. A. Stephenson

NEW BOOKS AND OTHER PUBLICATIONS

The Flotation Process. Compiled and edited by T. A. Rickard. Cloth, octavo, 370 pages, with illustrations. San Francisco: *Mining and Scientific Press*. Price 8s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

American mining men took a long time to realize the value of the flotation process, but when they did decide to accept the idea they pursued the subject with characteristic enthusiasm. Probably the scarcity of published information relating to the Minerals Separation process caused the early lack of interest, and it is more than a coincidence that the American investigations and researches should commence in earnest immediately after the issue of Theodore Hoover's book three or four years ago. That book formed and still forms the standard authority on the subject, describing the methods and processes in such a way that the independent inquirer can become fully acquainted with them and can base upon it his own researches and investigations. During the last two or three years every research laboratory in America, at college or mine, has been occupied with these investigations, and the workers have freely given their results to the public. When Mr. Rickard resumed the editorship of the *Mining and Scientific Press* a year ago, he found the time ripe for a campaign of publicity on the subject, and there were hosts of investigators ready to provide him with material. His personal contact, during his previous six years residence in London, with the original inventors, the Elmore Brothers, Sulman & Picard, Theodore Hoover, and others, made it appropriate that he should head the endeavours for securing a thorough appreciation of the principle of flotation in the United States by the publication and dissemination of information regarding it.

The articles that have appeared in the *Mining and Scientific Press* during the past year are now reprinted in book form. A number of them have already received notice in our 'Mining Digest.' In particular we may mention the papers on the science of the subject by T. M. Bains, O. C. Ralston, C. T. Durell, and Mr. Rickard himself, on the application of flotation to gold metallurgy by Charles Butters, and on the Callow process by the inventor. Though these papers do not disclose any new principle (for after all the Callow process employing the expanding rising bubble is only a variation of the Elmore vacuum process) they do present a great deal of detailed information and provide food for study and thought.

Copper, from the Ore to the Metal. By Hugh K. Picard. Cloth, octavo, 130 pages, illustrated. London: Sir Isaac Pitman & Sons Ld. Price 2s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

There are many well known books of unusual value occupying small space and published at a low price, such as Stopford Brooke's 'English Literature' and Rutley's 'Mineralogy.' To this select list must be added Picard's 'Copper,' for within its small compass is contained a wonderful amount of information cleverly put together and useful both to the student of technology and to the business man. The author does not plunge *in medias res*, as many technical writers are apt to do, but presents his facts in logical sequence. There is no attempt at elaboration of detail or desire to pose as an authority on mysteries, so that the book is perfectly comprehensible and thoroughly informing. Naturally it is not intended for the experienced practitioner, and the author makes no such claim. But as a plain straightforward statement of the successive treatments of copper ores and intermediate products, it fills the proverbial long-felt want. The first chapter describes the uses of copper, its ores, and its alloys. Then come chapters on concentration, roasting, the blast-furnace, consideration of blast-furnace products, pyritic smelting, and reverberatories. Other chapters deal with bessemerizing, electrolytic refining, leaching methods, and the customs relating to the sale of copper and copper ores. The treatment of all these subjects is from the modern standpoint, flotation, basic linings for converters, and many other recent improvements being discussed. We miss, however, any reference to leaching with ammonia, which has come to the front again during the past two years.

The Metalliferous Deposits of Cornwall and Devon. By Douglas Stuart Spens-Steuart. This pamphlet is of timely interest, and will be read to advantage by people to whom the recent revival in the fortunes of Cornwall makes an appeal. Mr. Steuart gives an outline of the history of Cornish mining. He discusses the advantages of modern mining methods and plant, and indicates the best policy to pursue in reopening old properties. The price is 3s. 6d. net.

YEARLY REPORTS OF MINING COMPANIES

Basset Mines.—This company was formed under limited liability in 1896 to acquire the Basset and South Frances tin mines, situated to the south of Carn Brea hill, near Camborne, Cornwall. Francis Oats, of the De Beers Company, is chairman, and his son, Francis Freethy Oats, is vice-chairman. The mines are troubled with water to a much greater extent than those to the north of the hill. The only dividends paid have been 15% and 7½% in 1911 and 1912 on the 35,500 preference shares. The report for the year 1915 shows that the staff of miners was seriously depleted, so only the richer stopes were worked. The amount of ore raised was 32,524 tons, as compared with 40,837 tons during 1914, the amount of concentrate sold was 557 tons as compared with 497 tons, the receipts £49,533 as compared with £41,230, and the yield per ton 38·4 lb. as compared with 27·2 lb. The loss on the year's working was £3023, following a loss of £14,145 the previous year. William James, the manager, reports that the lode to the west, under Daubuz's shaft, is improving at the 280 fm. level. In the winze below this level the ore is of good grade. Driving is in hand on the 310 fm. level with a view of ascertaining the value of the shoot in depth. Further information as to this ore is given elsewhere in this issue.

Canadian Mining Corporation.—This company was formed in London in March 1914 to acquire the greater part of the share capital of the Mining Corporation of Canada, a company registered at the same time under Canadian laws to consolidate the properties of the Townsite, Lake, City, Townsite Extension, and Little Nipissing companies, at Cobalt, Ontario. The company is under the control of Rose, Van Cutsem & Co., D'Arcy Weatherbe is the consulting engineer, and C. E. Watson is manager. The second annual report, now issued, covers the year 1915. During this time 56,196 tons of ore was hoisted from the Townsite section, 35,252 tons from the City, and 35,678 tons from the Lake, making a total of 127,126 tons. In addition, 62,082 tons of waste was broken, of which 53,524 tons was raised to the surface and 8559 tons was placed in old stopes. Of the ore raised, 766 tons was high-grade, averaging 2069 oz. silver per ton, and was shipped to the smelters; 260 tons was low in silver and high in cobalt, and was also shipped; and 131,853 tons was concentrating ore averaging 22·16 oz. silver per ton. The Lake concentrating ore, 34,720 tons, was treated at the Lake mill, the products being 915 tons of jig and table concentrates averaging 942 oz. silver per ton, and 4887 tons of slime averaging 15 oz. silver per ton. The 97,132 tons of concentrating ore from the Townsite and City gave 1739 tons of concentrate averaging 980 oz. silver per ton, and 28,796 tons of slime averaging 10 oz. silver per ton. The concentrates were shipped to the smelters, and the slimes were treated in the company's cyanide plant. The silver content of the total ore and concentrate shipped was 4,209,965 oz., and the actual yield from the slime 353,992 oz., making a total of 4,563,959 oz. The smelters' report shows that 4,102,228 oz. silver was extracted from the ore and concentrate, so that the actual yield of silver from the ore raised was 4,456,220 oz. The company's percentage of recovery of the silver content was 90·7%. The accounts show a revenue of $2,397,539 from silver, and $17,217 from cobalt. Other income brought the total revenue to $2,633,682, or $19·82 per ton of ore. The total cost was $1,349,541 or $10·15 per ton, leaving a profit of $1,284,140, or $9·67 per ton. Out of the profit, $90,745 was spent on capital account, chiefly on the drainage of Cobalt lake. The sum of $518,750 was paid as dividend, and $674,645 was carried forward. The English company received £100,433 from this dividend, and distributed £95,570, being at the rate of 6¼% on the 1,529,130 shares of £1 each. The total reserves are estimated at 36,246 tons, containing 2,594,675 oz., in the stopes, and 64'889 tons, containing 1,343,320 oz., in the dumps. The prospects for finding further ore at the Townsite are not bright, but at the Lake, City, and Townsite Extension there are good chances for discovering additional ore. The directors are considering the advisability of trying Russia as affording opportunities for mining activity, and they have already secured an option on gold-quartz properties in the Yenisei district.

Ducktown Sulphur, Copper, and Iron.—This company was formed in London in 1891 to acquire copper-sulphur mines in Tennessee, U.S.A. J. G. Gordon is chairman and managing director, W. Y. Westervelt is consulting engineer, and C. W. Renwick is manager. Dividends have been paid since 1895. A sulphuric acid plant was erected in 1909. The report for the year 1915 shows that 150,400 tons of ore was raised, and that 5,370,000 lb. of copper and 41,295 tons of 60% acid were produced, as compared with 169,000 tons, 5,862,000 lb., and 45,770 tons respectively during 1914. The accounts show a gross profit of £68,884, and after the payment of £5777 for London expenses, £7869 as interest on debentures, allowing £9000 for depreciation, and allocating £9000 to income tax and excess profits tax, the net profit was £41,382, out of which £27,472 was paid as dividend on the ordinary shares, being at the rate of 13¾%, and £13,486 was paid on the founders' shares. Developments at the Mary mine have added to the reserve, which now stands at 1,000,000 tons averaging not less than 2% copper and 17% sulphur. At the Isabella mine, the reserve remains at 2,500,000 tons averaging 0·8% copper and 29% sulphur. It is expected that at the East Tennessee mine 30,000 tons averaging over 2½% copper and 8% sulphur remains to be extracted, with possibly some chance of additional ore being found. The reason why the output showed a decrease as compared with the results for 1914 is that the Supreme Court of the United States, as the result of lawsuits, has ordered that the amount of sulphur discharged into the atmosphere during the summer is to be reduced to a minimum, so that the work done at the furnaces is restricted. The demand for 60° acid has diminished lately owing to the decrease in the production of phosphate fertilizers, so the sulphuric acid plant has been modified so as to produce strong acid.

Mason & Barry. — This company was formed privately in 1858 to work the San Domingos sulphur and copper mine at Mertola, Portugal, just over the Spanish border, and on the same mineral belt as the Rio Tinto and Tharsis. The company was expanded in 1878 and public subscriptions invited. The report for 1915 shows that 192,942 tons of ore was raised, as compared with 259,238 tons in 1914, and 378,929 tons in 1913. The fall is due to the loss of the German market for pyrite. The dividend for the year was £55,551 or 30%, double the distribution for 1914, the rise being caused by the advance in the price of copper.

Tharsis Sulphur & Copper.—This company has its headquarters in Glasgow and operates the Tharsis and Calanas sulphur and copper mines in the south of Spain. The chemical firm of Tennants is largely interested in it. As the pyrite is mostly shipped to

Great Britain, the output has not been substantially curtailed by the war. The report for 1915 shows that 23,642 tons was mined at the Tharsis and 386,058 tons at the Calanas, being increases over 1914 of 4694 tons and 41,957 tons respectively. The amount of ore, raw and washed, shipped amounted to 546,536 tons, as compared with 517,688 in 1914, and of copper precipitate 1541 tons as compared with 1611 tons. The production of refined copper was 3970 tons as compared with 3605 tons, the increase being partly due to the greater quantity (amount unspecified) of precipitate purchased. The net profit for the year was £103,291, and £125,000 was distributed as dividend being at the rate of 10%, as compared with 12½% the year before. The diminution in the profits is due to the company being saddled with the increased cost of freight. Since the beginning of operations in 1868, the dividends have totalled £10,289,682 or 910%, and £2,576,799 has been written off property account. The mines, buildings, and railways in Spain now stand on the books at £127,500, and the cash resources are £1,009,378. The nominal capital of the company is £1,250,000.

Namaqua Copper.—This company was formed in 1887 to acquire copper mines at Concordia, in the western part of the Cape Province, South Africa, not far from the property of the Cape Copper Co. Dividends have been paid continuously, except during the years 1891 to 1894, 1908, and 1909. The report for the year 1915 shows that the ore reserve continues to decrease owing to the deposits having been fully explored, but on the other hand the stopes have yielded more ore than estimated. Smelting had to be suspended from September 24 to November 4 owing to the non-arrival of coke supplies. Another adverse circumstance was the breakdown of the Krupp ball-mill on March 26, and the consequent stoppage of the Elmore concentration plant, which ordinarily supplies a rich concentrate to the smelter. A Grondal ball-mill is now being erected. During the year 24,876 tons averaging 5·9% copper was raised from the Tweefontein mine, and 4794 tons averaging 5·67% copper from the Henderson. In addition 2961 tons averaging 4·5% copper was taken from the outcrop and dump of the Wheal Julia and sent to the smelter, and 479 tons averaging 2·18% was sent to the precipitation heaps from the same mine. The smelter treated 17,403 tons of ore, 10,194 tons of briquettes, and 262 tons of magnetic tailing, the total being 27,859 tons. The yield of copper matte was 3228 tons, containing 1778 tons of fine copper. Copper precipitate containing 48 tons of copper was obtained from the leaching heaps. To these heaps there was delivered 2631 tons of material, partly oxidized ore and partly slime and tailing. The accounts show an income of £157,645 from the sale of ore and matte, and a net profit of £39,083, out of which £37,732 has been distributed as dividend, being at the rate of 20%. The reserve of ore is estimated at 66,731 tons, mostly at Tweefontein, averaging 6% copper, a decrease of 14,144 tons on the year. In addition 40,000 tons of old tailing and slime, averaging 5%, can be smelted, and 25,000 tons averaging 3 to 4% is available for treatment in the Elmore plant. William Rich is managing director, James Garland is manager, and Frederick A. Evans is metallurgist.

Globe & Phoenix Gold.—This company was formed in 1895 to acquire gold mines in the Sebakwe district of Rhodesia, which are situated 140 miles north of Bulawayo. The Globe did not last long, but the Phœnix has proved to be by far the most profitable gold mine in Rhodesia. As the company is at present a party in the celebrated lawsuit in connection with the ownership of a branch or parallel vein, the directors give a minimum of information in the report for 1915. The yield of gold was £412,073, the tonnage not being stated, and the working cost at the mine was £171,494. The sum of £48,678 has already been paid as expenses in connection with the lawsuit, and an additional £72,000 has been allocated out of the year's profit to the litigation reserve fund. Income tax provision absorbed £25,387, and £9281 was written off for depreciation. The shareholders received dividends totalling £80,000. During the previous year, 1914, the yield of gold was £485,007 and the dividends £240,000. No estimate of the ore reserve has been made since March 31, 1915, when the tonnage was calculated at 189,200, and the average content 29·4 dwt. per ton. The many examinations of the mine made by engineers and geologists for the purposes of collecting evidence for the lawsuit have been beneficial in other ways, for the information obtained will help in determining the best policy for future development. The directors have under consideration certain plans for increasing the rate of output, and Theodore Haddon, the manager, is at present engaged in making investigations as to the relative merits of the alternative proposals.

Lonely Reef Gold.—This company was formed by Lewis & Marks in 1910 to acquire a group of partly developed gold mines, together with a metallurgical plant, situated 55 miles north of Bulawayo, Rhodesia. Developments continued to be satisfactory down to the 8th level, below which again, down to the 13th level, the length of the ore-shoot became shorter and the average gold content less. The position as disclosed in the report for 1915 appears to be substantially better than a year ago, for the reserve has been increased as to both tonnage and assay-value, and the assay-value on the lowest level, the 15th, shows a considerable advance over the figures for the 9th to the 13th levels. The reserve is estimated at 157,279 tons averaging 15 dwt. per ton, as compared with 140,042 tons averaging 14·6 dwt. a year ago. The 15th level had only been driven 103 ft. at December 31, and the ore averaged 27·9 dwt. over a stoping width of 55 inches. At the time the report of S. H. Boright, the acting general manager, was written, February 18, the 15th level had been extended to 180 ft., and the average content was no less than 73 dwt. over 47 inches. On the 7th level the ore-shoot was 850 ft. long and assayed 33·8 dwt. over 50 inches. On the 13th it was 424 ft. long and averaged 17·6 dwt. over 47 inches. In order to keep the ore reserves well ahead of the mill requirements the shaft was sunk direct from the 13th to the 15th level, and the 14th level will be developed by a winze from the 13th and a rise from the 15th. During the year under review, 56,910 tons of ore was raised, averaging 14·6 dwt. per ton. The yield by amalgamation was 7673 oz. and by cyanide 29,126 oz., making a total of 36,799 oz., or 12·9 dwt. per ton. The value, including that of 1753 oz. silver, was £154,712. The working profit was £60,973, out of which £10,444 was allowed for depreciation, and £13,279 for income and other taxes. The shareholders received £35,230, being at the rate of 15%. Operations were restricted during the latter months of 1915 owing to a breakdown of part of the power plant, so that the total tonnage for the year was 4680 less than in 1914; and owing to the lower grade of the ore treated, the yield per ton was 1·7 dwt. less. These two circumstances combined caused the yield of gold to be £37,648 less, and the dividend £14,793 less.

Consolidated Langlaagte.—This company belongs to the Barnato group, and was formed in 1902 as a consolidation of the Crœsus and Langlaagte Star companies operating in the western part of the central Rand. Deep level claims were acquired in 1908. The Ferreira-Crown Reef dike upthrows the reef and brings it 1100 ft. nearer the surface. It became necessary, therefore, to make an independent scheme for working the deposits to the south of the dike, and two new shafts were sunk. Milling commenced in 1905 with 140 stamps. In 1912 a new mill with 100 stamps and 10 tube-mills was substituted. The first dividend was paid in 1913. The report for the year 1915 shows that 665,226 tons of ore was raised, and after the rejection of 4% waste, 636,300 tons, averaging 6·3 dwt., was sent to the mill. The yield of gold by amalgamation was 138,023 oz., and by cyanide 55,158 oz., making a total of 193,181 oz. worth £820,467, or 25s. 9d. per ton. The working cost was £462,831 or 14s. 6d. per ton, leaving a working profit of £357,636, or 11s. 3d. per ton. Out of the profit, £178,000 was written off for depreciation, £41,064 was paid as taxes, £11,412 as interest on debentures, and £237,500 was distributed as dividend, being at the rate of 25%. During the year £75,000 debentures were redeemed, leaving £195,000 outstanding. These debentures were issued for the purpose of providing for the cost of the new metallurgical plant. The ore milled was greater by 58,200 tons as compared with 1914, the working profit greater by £46,046, and the amount distributed in dividend greater by £47,500. W. L. White, the consulting engineer, reports that the ore reserve at December 31 was 2,248,656 tons averaging 6·5 dwt., as compared with 2,220,707 tons averaging 6·9 dwt. the previous year. The development in the lowest levels below the dike has disclosed ore of lower grade recently, and to this extent the prospects are not as good as they were a year ago. Of the ore mined during the year, 25% came from reclamation in the upper levels of the old part of the property.

Meyer & Charlton.—This company belongs to the Albu group, and was formed in 1888 to acquire a property on the outcrop in the central Rand. In 1909 an additional block on the dip was acquired. This mine has yielded as high-grade ore as any on the Rand, and unlike some of its neighbours is still producing similarly rich ore at depth. The report for the year 1915 shows that 183,297 tons of ore was raised, and after the rejection of a small amount of waste, 176,400 tons was sent to the mill. The yield by amalgamation was 44,046 oz., by cyanide 50,145 oz., and from concentrate 1503 oz., the total being 95,697 oz., worth £401,726. The yield per ton was 10·85 dwt., or 45s. 6d. The working cost was £163,196 or 18s. 6d. per ton. The shareholders received dividends of £160,000, being at the rate of 80%, and in addition £100,000 was distributed as a special bonus, being at the rate of 50%. Of the ore raised about one-half came from the rich Main Reef Leader and the rest was low-grade ore from the South and Main Reefs. The ore reserve on December 31 amounted to 485,246 tons averaging 12·5 dwt. over 53 inches. Of this, 273,900 tons averaging 18·4 dwt. over 46 in. was in the Main Reef Leader, 149,921 tons averaging 4·4 dwt. was in the South Reef, and 61,425 tons averaging 6·5 dwt. was in the Main Reef. As compared with the figures a year ago, the reserve tonnage in the Main Reef Leader has been maintained, but the gold content shows a drop of 1·9 dwt. per ton. In addition to the fully developed ore, 46,566 tons of partly developed ore is estimated to average 19·87 dwt. per ton. Since the commencement of operations in 1888, the total ore milled has been 2,659,390 tons, the receipts from gold sold £5,320,901, and the dividends £1,695,308.

Crown Mines.—This company was formed in 1909 as a consolidation of the Crown Reef, Crown Deep, Robinson Central Deep, Langlaagte Deep, and other properties in the central Rand. The control is with Rand Mines Limited, R. C. Warriner is consulting engineer, and A. J. Brett is manager. A proposition made by the directors a year or two ago to absorb the Robinson mine was not generally acceptable and was consequently withdrawn. At the time of the consolidation large sums in hand were devoted to reorganization of underground working, and additional capital to the extent of £1,000,000 was raised by the issue of debentures. The development has not disclosed ore of as high a grade as was expected at the time of the consolidation nor have the costs been reduced as much as estimated. Consequently the dividends have been much below the figure prognosticated, 130%. The report for the year 1915 shows that 2,816,431 tons of ore was raised, and after the removal of waste, 2,501,450 tons, averaging 6·38 dwt. gold, was sent to the mills. The extraction by amalgamation was 549,255 oz., and by cyanide 213,806 oz., making a total of 763,061 oz., worth £3,164,343. The yield per ton milled was 6·11 dwt., or 25s. 4d. The working cost was £2,017,791, or 16s. 2d. per ton, leaving a working profit of £1,146,552, or 9s. 2d. per ton. Out of the profit, £26,169 was spent on shaft-sinking and £71,930 on equipment, £19,979 was paid to the Government for undermining rights and £159,584 as profits tax and war levy, £85,750 was devoted to the purchase of debentures, £43,288 was paid as debenture interest, and £22,455 was appropriated to the Miners' Phthisis fund. The shareholders received £611,068, being at the rate of 65%. During the previous year the ore milled was 2,287,600 tons, the yield £2,975,687 or 26s. per ton, the working profit £1,191,628, and the dividend £799,090 or 85%. The ore reserve at December 31 was estimated at 9,938,000 tons, averaging 6¼ dwt., as compared with 9,369,000 tons, averaging 5·9 dwt. the year before. More hand labour is now available, so that narrower stopes can be taken; hence the decrease in the tonnage and increase in the assay-value in this year's figures for ore reserves. Of the banket developed below the 13th level exactly half is classed as profitable ore; the proportion is greater in the western section and less in the eastern section. During the year the development of the ground to the south of the dike has been commenced.

Robinson Gold.—The Robinson mine, the richest producer of the Rand, is now within measurable distance of exhaustion. The report for the year 1915 shows that 662,857 tons of ore was raised, 178,974 tons coming from the Main Reef, 228,641 tons from the Main Reef Leader, and 255,242 tons from the South Reef. Of the total from the Leader and South Reef, 143,944 tons came from the stopes and 339,939 tons from reclamation. This ore, together with 53,892 tons from the dumps, was sent to the sorting stations, where 3·7% waste was removed. The mill treated 688,800 tons averaging 7·1 dwt. gold per ton. The extraction of gold by amalgamation was 150,762 oz., and by cyanide 80,717 oz., making a total of 231,479 oz., worth £959,253, the yield per ton milled being 27s. 10d. The working cost was £468,801, or 13s. 7d. per ton, leaving a profit of £490,451, or 14s. 3d. per ton. Out of the profit, £46,103 was paid to the Government as annuity in respect of undermining rights, and £64,056 was paid as profits tax and war levy. The shareholders received £385,000, being at the rate of 14%. The tonnage milled did not differ much from the average of the previous three years, but the yield per ton has steadily increased, being 43s. 8d. in 1912, 35s. 9d. in 1913, and 32s. 2d. in 1914. The stopes in the Main Reef Leader and South Reef are nearly exhausted, and the calculated reserve, 565,100 tons, consists mostly of shaft pillars and reef packs. Of profitable Main Reef 418,200 tons is accessible, and of this, 119,600 tons is in the form of packs. It is possible that other ore may be mined from the Main Reef, and that additional ore may be found between the 10th and 14th levels in the Leader and South Reef. Since the beginning of operations in 1888, the total yield of gold has been worth £20,480,944 extracted from 9,295,597 tons mined. During the first year of operations the yield per ton was about 3 oz. Just before the Boer war the yield was 17 dwt., and when the reserves in the Leader began to diminish in 1912 the yield was 10½ dwt.

City Deep.—This company belongs to the Rand Mines group, and was formed in 1899 to acquire property in the central Rand on the dip of the City & Suburban and Meyer & Charlton. In 1908 adjoining property on the dip of the Wolhuter and New Goch was acquired. It was not until the latter year that development was commenced in earnest. This mine has caused some disappointment, as the capacity of the metallurgical plant erected has been much ahead of development. Though the amount of ore available has been gradually increased, it is still short of requirements. During 1915 an average of 150 Californian stamps and 4 Nissen stamps were at work out of 200 and 8 respectively. The report for 1915 shows that 784,150 tons of ore was raised, and after the rejection of 13½% waste, 677,200 tons, averaging 9·76 dwt. per ton, was sent to the mill. The extraction of gold by amalgamation was 219,510 oz., and by cyanide 95,518 oz., making a total of 315,028 oz., worth £1,306,045, or 38s. 7d. per ton milled. The working cost was £690,622 or 20s. 5d. per ton, leaving a working profit of £615,422 or 18s. 2d. per ton. Out of the profit £36,183 was spent on plant and shaft-sinking, and £93,625 was paid as profits tax and war levy. The shareholders received £421,875, being at the rate of 33¾% on the capital of £1,250,000. As compared with the previous year, the tonnage milled showed an increase of 171,900 tons, and the working profit an increase of £216,273. The working cost was 2s. per ton less, and the yield per ton 5d. more. The ore reserve on December 31 was estimated at 2,733,600 tons averaging 9·9 dwt. in the Main Reef Leader, 227,600 tons averaging 4·7 dwt. in the Main Reef, and 15,600 tons averaging 4·7 dwt. in the South Reef. A year ago the reserve in the Leader was estimated at 2,329,000 tons averaging 10·2 dwt. During 1915 the tonnage raised consisted of 555,504 tons from the Leader, 266,645 tons from the Main Reef, and 2001 tons from the South Reef. A Butters filter with a capacity of 45,000 tons per month is being provided.

Modderfontein B. Gold Mines.—This company was formed in 1908 by the Rand Mines group to develop property in the Far East Rand to the east of New Modderfontein. H. Stuart Martin is consulting engineer, and C. L. Butlin is general manager. The plant was increased in 1914 by the addition of 16 Nissen stamps, and another tube-mill was added in September 1915, making 80 Californian, 16 Nissens, and 5 tube-mills in all. The report for the year 1915 shows that 576,574 tons of ore was raised and was, together with 22,797 tons from the surface dumps, sent to the sorting station. After the rejection of 15% waste, 510,700 tons averaging 10·1 dwt. was sent to the mill. The yield of gold by amalgamation was 137,941 oz., and by cyanide 111,290 oz., making a total of 249,231 oz. worth £1,033,517. The extraction was 9·78 dwt. equal to 40s. 6d. per ton of ore milled. The working cost was £403,602 or 15s. 10d. per ton, leaving a working profit of £629,915 or 24s. 8d. per ton. Since the additional tube-mill was installed, the capacity of the plant has been 45,000 tons per month. As compared with the previous year, the ore milled was 69,700 tons more, the yield per ton 4s. 8d. higher, the working cost 3d. higher, and the working profit £183,575 greater. Out of the working profit, £10,427 was spent on capital account, and £88,543 was paid as profits tax and war levy. The dividends absorbed £472,500, being at the rate of 67½%. Development during the year disclosed 537,556 tons of ore averaging 9·25 dwt., and the total reserve on December 31 was estimated at 2,790,740 tons averaging 8·75 dwt. Indications tend to show that the whole of the southwest area is likely to contain ore of good grade. To the south of the central hoisting shaft there appears to be a zone of unprofitable ground.

Van Ryn Deep.—This company belongs to the Barnato group, and was formed in 1902, as a fusion of the Van Ryn Deep and Kleinfontein Deep, to acquire deep level claims in the Far East Rand, on the dip of the Van Ryn, Kleinfontein, and Benoni. The property is above the Brakpan, and to the west of the New Modderfontein, Modder Deep, and Government Areas. Two vertical shafts near the Kleinfontein boundary intersected the reef in 1909 and 1910 at depths of 1700 ft. and 1625 ft. respectively. The mill contains 80 heavy stamps and 8 tube-mills, and was started in July 1913. The first dividend was paid shortly after the end of 1913. The report for the year 1915 shows that 565,451 tons was hoisted, and together with 18,980 tons from the dump, sent to the sorting station. After the rejection of 12·9% waste, 508,710 tons averaging just under 9 dwt. per ton was sent to the stamps. The yield by amalgamation was 149,875 oz., and by cyaniding 73,881 oz., a total of 223,756 oz., worth £950,494, being an extraction of 8·8 dwt. or 37s. 4d. per ton milled. The working cost was £433,186, or 17s. 0d. per ton, leaving a working profit of £517,308, or 20s. 4d. per ton. Profits tax and war levy absorbed £68,862, and £34,084 was allowed for depreciation. The shareholders received £388,989, the dividend being at the rate of 32½%. The ore reserve on December 31 was calculated at 2,044,108 tons averaging 8·4 dwt. over a stoping width of 62 in. Development during the year has given excellent results. The eastern section of the mine has always done well, and recently the bottom levels in the western section have substantially improved.

Government Gold Mining Areas (Modderfontein) Consolidated.—This company belongs to the Barnato group, and was formed in 1910 to acquire mining rights in the Far East Rand to the south of New Modder and Modder B, between Brakpan on the west and Geduld on the east. The lease of the property was acquired from the Government, which will share largely in the profits. The capital of the company is £1,400,000, represented almost entirely by cash subscribed and devoted to development and erection of plant. Milling commenced in October 1914 with 100 stamps and 10 tube-mills. This plant is now being duplicated, and before long the monthly capacity will have been increased from 50,000 tons to 100,000 tons. The report for 1915 shows that 484,622 tons of ore was hoisted from the stopes, and 123,924 tons from development faces. This, together with 49,841 tons from the dumps, was sent to the sorting stations, where 12% was removed as waste. The mill treated 576,100 tons, averaging 6¼ dwt. per ton. The yield by amalgamation was 92,378 oz., and by cyanide 77,034 oz., making a total of 169,412 oz., worth £719,625, or 25s. per ton. The working cost was £563,414, or 19s. 7d. per ton, leaving a working profit of £156,210, or 5s. 5d. per ton, out of which £16,429 was paid to the Government as its share of profits. No dividend was distributed. The grade of the ore milled increased gradually from 20s. 5d. per ton to 26s. 10d. per ton during the year. The reserve on December 31 was estimated at 3,665,000 tons, averaging 6·9 dwt., as compared with 2,451,580 tons, averaging 5·8 dwt. at the beginning of the year.

Modderfontein Deep Levels.—This company was formed in 1899 to acquire gold-mining rights in the Far East Rand, on the dip of the New Modderfontein. The control is with the Goerz group. Shaft-sinking began in 1910, and the two shafts cut the banket in 1912 at 2990 ft. and 3003 ft. respectively. A metallurgical plant containing 60 stamps and 6 tube-mills was started at the end of 1914. The report for the year 1915, now issued, shows that 440,473 tons of ore was mined, and after the rejection of 5% underground and 7% on the surface, 390,150 tons averaging 8·7 dwt. was sent to the mill. The yield of gold by amalgamation was 91,120 oz. and by cyanide 67,608 oz., making a total of 158,728 oz. worth £671,931, being 8·14 dwt. or 34s. 5d. per ton of ore milled. The working cost was £333,501 or 17s. 1d. per ton, leaving a profit of £338,429 or 17s. 4d. per ton milled. The ore reserve is estimated at 2,670,000 tons averaging 8·3 dwt. over a stoping width of 73 in. These figures show an increase of 220,000 tons and 0·3 dwt. as compared with the previous year. The metallurgical plant is being increased, so as to raise the monthly capacity from 30,000 to 40,000 tons. Out of the working profit for the year, £55,704 was paid as taxes, etc., £70,000 was allocated to general expenditure, and £175,000 was distributed as dividend, being at the rate of 35%.

Geduld Proprietary Mines.—This company belongs to the Goerz group, and was formed in 1899 to acquire gold-mining rights in the Far East Rand. Development was commenced in the year 1904. The two shafts in use, Nos. 2 and 3, cut the banket at depths of 1694 ft. and 1839 ft. respectively. Milling was commenced in 1908, but was suspended shortly afterward owing to the workings being flooded, and was not resumed until early in 1910. In 1913 the metallurgical plant was increased, and it now contains 60 stamps and 5 tube-mills. At the present time the plant is being extended and re-arranged, and the capacity will be thereby increased from 25,000 to 40,000 tons per month. The report for the year 1915 shows that 314,358 tons of ore was raised, and 303,990 tons was sent to the stamps. The extraction by amalgamation was 55,318 oz., and by cyanide 55,472 oz., making a total of 110,790 oz., worth £468,675, being a yield of 7·3 dwt. or 30s. 10d. per ton. The working cost was £327,264, or 21s. 6d. per ton, leaving a working profit of £141,410 or 9s. 4d. per ton. As compared with the results for 1914, the tonnage increased by 58,855 tons, the yield per ton decreased by 1s. 5d., the working cost per ton decreased by 2s. 10d., and the working profit increased by £47,220. Out of the working profit, £22,085 was paid as taxes, and £97,000 was distributed as dividend, being at the rate of 10%. The first dividend paid by the company was one of 5% for 1914. The ore reserve was calculated on December 31 at 2,100,000 tons averaging 7·7 dwt. per ton, an increase of 200,000 tons and 0·6 dwt. over the year. During the past year the supply of native labour has been ample, but a smaller amount is required than in some other mines on the Rand owing to 75% of the ore being obtained by machine drills. The amount of water pumped was 800 million gallons, and the income from the sale of water was £4031.

New Kleinfontein.—This company belongs to the Anglo-French Exploration group and was formed in 1893 to acquire an outcrop property in the Far East Rand. In 1914 the Benoni and Apex properties were absorbed. The report for 1915 shows that 763,254 tons of ore was raised, of which 486,062 tons came from the Kleinfontein stopes, 156,260 tons from reclamation in upper levels in Kleinfontein, 64,360 tons came from Benoni stopes, and 56,572 tons from development faces. After the rejection of 16% waste, 636,150 tons averaging 6·4 dwt. per ton was sent to the mill. The yield by amalgamation was 130,278 oz., and by cyanide 65,543 oz., making a total of 195,821 oz. worth £831,983. The yield per ton milled was 6·15 dwt. or 26s. 1d. The working cost was £548,416 or 17s. 3d. per ton milled, leaving a working profit of £283,567. Out of this profit, £28,841 was paid as taxes and war levy, and £117,306 was spent on plant for the development of the absorbed property. The shareholders received £115,154, being at the rate of 10%. It is expected that the new plant for the Apex section, having a capacity of 25,000 tons per month, will be ready in July. The ore reserve at the Kleinfontein is estimated at 1,766,929 tons averaging 5·6 dwt., at the Benoni 612,365 tons averaging 4·93 dwt., and at the Apex 487,647 tons averaging 6·09 dwt.

Mount Boppy Gold.—This company was formed by John Taylor & Sons in 1899 to acquire a gold mine in the Cobar district of New South Wales. Metallurgical plant was acquired from the Gallymont company, which had previously, under the same control, unsuccessfully worked a gold mine in the Bathurst district of the same state. The mining operations at Mount Boppy were uniformly successful from 1902 to 1911. In 1912 a severe drought and the change of the ore from free-milling to sulphide made if necessary to raise additional working capital. During the last year or two development has not disclosed any ore below the 780 ft. level, and more attention has been given to exploration laterally, with good results. The report for the year 1915 shows that 79,526 tons of ore was raised, and that the total gold extracted amounted to 40,861 oz., 12,396 oz. being recovered by amalgamation, 14,598 oz. by cyaniding, and 1459 oz. in concentrate sold to smelters. The value of the gold was £119,589, and the working profit was £26,936. It has been necessary to write off £7769 on shares held in the North and South Boppy companies, and £8113 for depreciation of, and current expenditure on, mine plant. The preference shareholders received £3000, being at the rate of 10%, and £7550 was distributed on the total capital of the company, £151,000, including the preference shares, being at the rate of 5%. The distribution for 1914 was £14,325. The best days of the company were from 1905 to 1908, when the average yearly distribution was £55,000, or 45%. James Negus, the superintendent, describes the exploration from the upper levels in detail. The ore reserve at December 31 was estimated at 215,956 tons, as compared with 199,559 tons the year before. The treatment of accumulated sand and slime, amounting to 300,000 tons, is under consideration. A large amount of ore, about 100,000 tons, has been left in the mine, as its removal might damage one of the shafts. A plan is being considered for sinking a new shaft, and if this is adopted, the ore in question could be removed.

Ivanhoe Gold Corporation.—This company was floated in 1897 by Whitaker Wright to acquire a gold mine at Kalgoorlie from a Melbourne company of similar name, which had done well for its shareholders during the previous two years. Since 1903, Bewick, Moreing & Co. have been consulting engineers. Handsome dividends have been paid continuously, though, during the last two years, owing to the orebody passing into porphyry and the gold content of the ore being thereby seriously diminished, the yield, profits, and dividends have suffered slightly. The report for the year 1915 shows that the tonnage sent to the treatment plant has been up to the average of the past 10 years. The amount of ore raised and treated was 238,514 tons, estimated to average 36s. 9d. gold per ton. The yield by amalgamation was worth £102,343; the roasting and cyaniding of 23,299 tons of concentrate gave £82,068; £62,135 was obtained by the cyaniding of 111,480 tons of sand; and £133,876 from 103,635 tons of slime. The total yield was £380,440 or 31s. 10d. per ton, and the working cost in Australia was £259,499 or 21s. 9d. per ton. After payment of London expenses and taxes, a balance of £106,233 remained, out of which £105,000 was distributed as dividend, being at the rate of 10½% on the capital, £1,000,000. This dividend was the same as that for 1914, and it compared with 150% in 1913. Since the company purchased the mine, the output of gold has been £8,241,632 from 3,219,100 tons of ore, and the dividends have totalled £3,460,000. In addition, £953,659 has been written off the expenditure account for plant and development. The ore reserve is estimated at 1,026,801 tons averaging 36s. 10d. gold per ton, as compared with 998,718 tons averaging 37s. 3d. per ton the year before. Diamond-drilling has been actively conducted, but the limits of the porphyry dike have not yet been determined. The shaft is to be sunk to 3620 ft., and further drilling tried.

Sons of Gwalia.—This company was formed in 1898 to acquire a gold mine at Mount Leonora, in the North Coolgardie goldfield of Western Australia. Bewick, Moreing & Co. are the general managers. Dividends averaging 20% have been paid regularly since 1900. Four years ago the developments between the 13th and 17th levels were disappointing. Subsequently, on the advice of Dr. Malcolm Maclaren, lateral diamond-drilling was undertaken on the 18th and 19th levels, and an important parallel lode was discovered which restored the fortunes of the company. The report for the year 1914 shows that the main incline shaft has been sunk to 3288 ft., and a 22nd level opened at 3182 ft. Here the developments have on the whole given satisfactory results. The ore reserve at December 31 was calculated as being equal to four years supply for the mill, as compared with 3 years 8 months supply calculated a year ago. During the year under review, 163,379 tons was raised and sent to the mill, where 15,082 oz. of gold was extracted by amalgamation and 43,400 oz. cyanide, a total of 58,482 oz., worth £253,685, being an extraction of 30s. 5d. per ton. The working cost at the mine was £181,479 or 22s. 2d. per ton. After the allowance of £13,494 for depreciation and the payment of London administration expenses and income tax, a net profit of £51,726 remained, out of which £41,437 was distributed among the shareholders, being at the rate of 12½ per cent.

Broken Hill South Silver Mining.—The report for the half-year ended December 31 shows that the scale of operations have gradually expanded since arrangements were made in April 1915 by the Broken Hill Associated Smelters to take the output of lead concentrate, and it is expected that with the enlargement of the smelting plant now in hand the mine will be able to work at full capacity in the near future. During the half-year the ore raised and treated was 163,494 tons, as compared with 131,059 tons during the previous half-year, and 172,421 tons during the half-year before the war. The average assay was 14·6% lead, 14·8% zinc, and 7·5 oz. silver per ton. The yield of lead concentrate was 30,658 tons averaging 60% lead, 9·9% zinc, and 23·6 oz. silver; of zinc tailing 101,004 tons averaging 17·3% zinc, 3·1% lead, and 3·4 oz. silver; and of slime 24,140 tons averaging 9·9% lead, 14·4% zinc, and 6·1 oz. silver. The zinc tailing was delivered to the Amalgamated Zinc (De Bavay's), and 2992 tons of slime was sent with the lead concentrate to the Associated Smelters. The receipts amounted to £362,423. The working cost was £170,258, administration £5452, depreciation of plant £6900, interest on debentures £5902, and income tax and royalty £20,000. The dividends absorbed the sum of £90,000 on a paid-up capital of £163,692. W. E. Wainwright, the manager, reports that the reserve of ore has been maintained at 3,350,000 tons. Development at depth, however, is not at present showing a continuation of high-grade ore, and the small amount raised from the 1270 ft. level averaged 9·8% lead, 9·6% zinc, and 3·2 oz. silver per ton, which compares unfavourably with the general average quoted above. The first unit of the slime flotation plant has been completed.

North Broken Hill.—This company, like the South, details of which are given above, is now a part proprietor of the Port Pirie smelting works, and the output of ore is regulated by the capacity of the lead furnaces. During the half-year ended December 31, the ore raised totalled 138,484 tons averaging 16% lead, 13% zinc, and 7·5 oz. silver per ton. This was an increase of 15,000 tons over the figures for the previous half-year, and represents about 80% of the normal. The production of lead concentrate was 28,370 tons averaging 60·5% lead, 8·8% zinc, and 20·7 oz. silver. The zinc tailing, amounting to 64·418 tons, and averaging 16·6% zinc, 3·2% lead, and 3·5 oz. silver, was delivered to the Amalgamated Zinc (De Bavay's) company, and there was also produced 16,511 tons of slime, averaging 12·8% lead, 15·2% zinc, and 9·3 oz. silver. The working cost per ton, including development, was 18s. 2d. Development on the lowest level, at 1400 ft., has given good results, the assay-value of the ore being maintained. The reserve on December 31 was estimated at 3,000,000 tons. A study of the plans would indicate that the two shoots are merging at depth. The accounts show a profit of £133,625, and £120,000 has been distributed as dividend, being 20% on the capital, £600,000.

Waihi Gold.—This company was formed in 1887 to acquire gold-mining properties in the Thames district in the northern island of New Zealand. Dividends were first paid in 1893, and they continued on an increasingly handsome scale until 1910, when the lodes became impoverished in depth, and the rate of output of ore and the profits fell in a marked manner. The report for the year 1915 shows that 192,333 tons of ore was raised and treated, and the yield of bullion was worth £348,295. The yield per ton was 34s. 7d., of which 30s. 3d. was in gold and 4s. 4d. in silver. The working profit was £155,409, out of which £99,181 was distributed as dividend, at the rate of 20%. These results are much the same as those for 1913 and 1914. During 1909, the yield of gold was worth £959,594 from 416,813 tons, and £446,316 was distributed as dividend, and the yield per ton was 46s. The ore reserve has increased during the year, by 29,043 tons, and stood on December 31 at 806,052 tons, together with 673,896 tons in pillars, etc. Development on the 11th level disclosed considerable bodies of ore on the Royal and Edward lodes. No ore has been found in the Martha lode, and the prospects at the Empire lode are not great. Developments toward the east in levels 7 to 10 on the Royal lode have disclosed further ore. No. 4 shaft has been sunk to 1470 ft., and a station cut at 1447 ft., where a No. 12 level will be started.

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

EDGAR RICKARD, *Managing Director.* H. FOSTER BAIN, *Editor.* EDWARD WALKER, *Assistant Editor*

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CONTENTS.

REVIEW OF MINING

Introductory.—The chief item of interest during the past month has been the determination of the German selling contracts of the British Broken Hill and the Zinc Corporation by the aid of the powers under the new Trading with the Enemy Act. This has finally released the English companies operating in Australia from the tedious litigation in the English Courts. Mine owners in Australia are, however, no better off, owing to the drastic rules relating to the disposal of their products proposed by the Commonwealth Government. During the month, the prices of metals have continued to be erratic, thus affording further evidence that the conditions on which they are fixed are unreal. The price of silver, after soaring from 28½d. to 37d. at the end of April, soon began to sag on the offering of Chinese metal, and has receded to 30d. Standard copper continued its upward flight, but after reaching £155, rapidly fell back and now stands at £124. The price of zinc has eased very much during the last two weeks, owing to the outputs of many new works in America making their appearance on the market. The price, which in April exceeded £100, has fallen to £70. Tin has had a period of depression, and the price, after being fairly steady around £200 for two months or more, declined to £183, but has slightly recovered since.

Transvaal.—The output of gold on the Rand during May was 751,198 oz., and in outside districts 26,483 oz., making a total of 777,681 oz., worth £3,303,377, as compared with 728,399 oz., 26,273 oz., 754,672 oz., and £3,205,643 during April. The number of natives employed on the gold mines at the end of May was 194,765, as compared with 199,936 at the end of April, and 183,961 at the end of May last year.

In our last issue, both in this column and in our précis of company reports, we devoted much attention to the more prosperous mines on the Rand. In our précis this month we give details of a great many mines on the Rand that have not such a good record in the past or such a promise for the future. To gain an accurate idea of conditions on the Rand, a survey must be made of all the operations.

Long-term contracts have been made by most of the mining groups on the Rand with the Cassel Cyanide Company of Glasgow, and the British Cyanide Company, whereby the mines will take the whole of their cyanide requirements from these firms for the duration of the war, and for five years after its termination. Before the war, about three quarters of the supply came from Germany.

The Central Mining & Investment Corporation has been hard hit by depreciation in the market value of its holdings, and not only is most of the net profit for 1915, £325,027, applied to writing off these losses, but it has been found necessary also to cancel £4 of each £12 share, the total nominal capital being thus reduced by £1,700,000. The Corporation has purchased interests in the Geduld, Modder Deep, and Daggafontein companies, and owns, conjointly with Rand Mines, an area on the farm Vogelstruisbult, south of Daggafontein.

The quarterly report of Crown Mines for the period ended March 31 shows a decrease in the tonnage and profits. This position is due to the failure of the recently adopted policy of narrowing the stoping widths. The widths were substantially decreased by the liberal substitution of hand labour for machines, and the average yield per ton was raised by 0·5 dwt. It was found impossible, however, to maintain the tonnage under these conditions, in spite of the fact that 37 additional faces had been opened. The total yield was less and the cost per ton higher. The directors and engineers have therefore decided to revert to the former method of working. The economic problem of selective mining at depth is a difficult one. If the directors would permit the publication of greater details of their experience in this case, the mining fraternity would be greatly obliged.

The New Goch is nearing the end of its life. Last August the main shaft reached the southern boundary, and the bottom level, the 19th, is now being driven. The ore reserve is sufficient to last for a year and a half, and probably an equal amount or rather more remains to be developed. The ground at the deepest levels is much broken by faulting.

The Roodepoort United Main Reef is now in a more favourable position with regard to ore development, especially on the South reef in the Kimberley section, and the shares have consequently received attention. Much publicity has been given to a cable announcing a bore-hole result, with 7 inches assaying 39 oz. gold per ton, but these patches are well known on the Rand.

The proposed reorganization of the business of the Transvaal Coal Trust and the terms on which the Consolidated Mines Selection provide additional capital have not been received with unanimous approval. Sir George Albu, a member of the board, has issued a circular alleging that the deal is in favour of the Consolidated Mines Selection and against the interests of the Coal Trust. The meeting of shareholders at which the proposals are to be submitted will be held in Johannesburg on June 23, and no doubt the matter will then be further discussed.

The additional ten stamps at the Modder Deep were started early in June, and the monthly capacity will in future be 40,000 tons. The ore reserve is sufficient to supply the mill for five years.

Last month we made brief mention of the report on the resources of the Far East Rand made by Mr. R. N. Kotze, the Government Mining Engineer. Our Johannesburg correspondent refers to this report at some length elsewhere in this issue. It will be seen that Mr. Kotze excludes from his calculations all reef deeper than 5000 ft. Our correspondent supposes that this exclusion is due to Mr. Kotze's belief in impoverishment of ore in depth. We are inclined to think that the difficulty of supporting the roof was a more cogent factor.

Kimberley mines are preparing to resume underground work, and a force of men is being collected. Large plans for expansion and improvement were under consideration when the war opened. These have been necessarily set aside and for the present the immediate task is the clearing of the roads, repairing of chutes, and re-timbering of the drifts. The mines have been kept clear of water, and are in much better condition than might be anticipated.

Proposals to grant additional compensation to phthisis victims on the Rand who have exhausted the money already granted them are under consideration. The original allotments were not very exactly proportioned, so that some readjustment is inevitable. Steps should be taken, however, to preclude the waste of money granted in lump sums to beneficiaries. There is no good reason why the mines should pay over and over because a man is improvident, and reopening cases once settled leads the way to grave abuse.

Rhodesia. — The output of gold during April was worth £339,386, as compared with £335,368 in March, and £315,541 in April of last year. The yield at the Falcon showed a considerable drop, being £21,973, as compared with £27,834 from practically the same amount of ore, 19,400 tons.

The lawsuit brought by the Amalgamated Properties of Rhodesia against the Globe & Phœnix continues on its weary way. The whole of the month since our last issue appeared has been occupied by the speeches of counsel; and their end is not yet.

Last month we mentioned that a rich strike had been made at the Cam & Motor. The latest cable states that the newly discovered leader has been followed for 47 ft., over which distance the width is 13 inches, and the average assay-value £13 per ton.

The high price of copper induced the directors of the Bwana M'Kubwa company to re-start operations, and the concentration of rich oxidized ore was resumed in April.

The shares of Tanganyika Concessions have been greatly in request during the last two months, owing to the rapid increase in the smelting capacity. The output of copper during April was 2238 tons, and the yearly figure of 30,000 tons is within measurable distance. The present plans provide for a further extension to 40,000 tons per year.

West Africa.—The output of gold in West

Africa during April was worth £135,976, as compared with £150,987 in March, and £149,978 during April 1915. The yield per ton at Prestea Block A decreased from 32s. in March to 29s. in April, and the total from £41,294 extracted from 25,830 tons to £34,806 extracted from 24,000 tons. The fall is due partly to metallurgical difficulties and partly to fall in grade. Abbontiakoon showed a fall of £3247 and Abosso a fall of £4013.

The manganese deposits at Dagwin in the Wassaw district are to be developed conjointly by the Fanti Consolidated, the owners of the ground, and the Darwen & Mostyn Iron Company, a Lancashire firm of steelmakers. In all probability a separate company will be formed shortly. The deposit is not exactly a new discovery, for the Government Geologist for the Gold Coast, Mr. A. E. Kitson, described it in his report for 1914. The analysis made at the Imperial Institute showed a metallic content of 56%, which indicates that the ore is of excellent grade.

Australasia.—We refer in our editorial columns to the cancelling of the German contracts of the British-owned Broken Hill companies, and make comment on the proposals of the Commonwealth Government with relation to the treatment of ores and disposal of metals in the future.

The consent of the Treasury having been obtained, the long-contemplated absorption by the Sulphide Corporation of its subsidiary, the Central Zinc Co., has now been effected. The latter company receives 50,000 preference shares of £1 each and 50,000 ordinary shares of 15s. each in the Sulphide Corporation. An arrangement with the Government has also been made, whereby excess profits can be devoted to the extension of the plant, on similar terms to those recorded in our April issue, and the capacity of the smelter will accordingly be increased to 30,000 tons of zinc concentrate per year. The Central Zinc plant is at Seaton Carew, Durham, and its career so far has been disappointing.

The threatened embargo on the export of ore from Australia is causing disquietude in the antimony-gold district at Costerfield, Victoria. The ore is sent to St. Helen's, Lancashire, for treatment. It would not be sound commercially to transfer the smelting works to Australia, so that unless the Commonwealth Government relents, the Costerfield mines will have to be closed.

The Inspector of Mines for New South Wales considers the recently discovered gold lodes at Goobraganda as distinctly important. The deposit is near the left branch of the Goobraganda river and is 30 miles from Tumut. Alluvial deposits have been worked in this district for many years. The lodes and wall-rock are much decomposed and close timbering is necessary, so that a detailed geological examination is impossible. Several shafts have been sunk, the deepest being 55 ft. Independent samples have given high assay-values, anywhere between 1 oz. and 10 oz. per ton.

The Mount Lyell Co. has decided to exercise its option on the Tasmanian-Hercules-Primrose group of silver-lead mines. The reserve is estimated at 800,000 tons averaging 29% zinc, 7½% lead, 9½ oz. silver, and 2½ dwt. gold. Hydro-electric power is to be purchased from the Tasmanian Government.

India.—In our December issue we foreshadowed a reduction in the yield of gold at Champion Reef, owing to a fall in the grade of the ore developed at depth. The output has been gradually diminishing since the commencement of 1916, and in May the figures were 9540 oz., as compared with 10,918 oz. in May 1915. The mine is also suffering severely from so-called air-blasts, and during the last two or three months considerable damage has been done in this way. In order to prevent more serious consequences and to protect the development of the deeper levels, it has been found necessary to suspend stoping over a large area above the 41st level. At present it is impossible to forecast the effect of this check to stoping on the monthly output of the mine.

Cornwall.—Though the chief development at Dolcoath is in connection with the shallower ground between Stray Park and Harriet shafts, the bottom of the mine is also being energetically worked. In following a lode in a southerly direction on the 550 fathom level, that had been comparatively poor in the northern portion, some very much better ground was discovered. The last 70 tons reported produced

64 lb. per ton. This improvement in the bottom levels has briskened the market for Dolcoath shares.

The proposal of Mr. C. A. Moreing relating to the formation of a Cornish Mining Board is receiving general support. Mr. R. Arthur Thomas, the manager of Dolcoath, has called a meeting of representatives of mines for June 14, and we have no doubt that with the active backing of Mr. Thomas and Mr. Moreing the long-desired Board or Chamber will be established.

Since the adoption of the 'no profit, no dues' lease for the benefit of mines in Cornwall, a curious position has arisen as regards the rating of such mines, to which we have so far seen no public reference made. Under the Rating Act of 1874, tin, lead, and copper mines are assessed on the basis of the royalties paid in the previous year. This works satisfactorily where the rate of royalty is definitely fixed, but where no royalty is payable when no profit is earned, the mine escapes local taxation, except for the amount which is levied on the minimum rent. Obviously, this is unfair to other mines in the same district who have to pay royalty on all the minerals raised, whether a profit is earned thereon or not. This is a matter to which the attention of the proposed Mining Board could profitably be devoted.

The establishment of a branch of the Workers' Union in the Mining Division of Cornwall, with an office at Wheal Agar, Carn Brea, is a sign of the times. So far, the miners generally have held aloof from this Union, particularly the older men, and with the high wages ruling at present, the Union is unlikely to meet with much success. Any attempt, however, to improve efficiency by the elimination of the slacker and what is known locally as the 'pick and shovel miner' (that is a man whose main energies are devoted to the cultivation of his cabbage patch and whose hours underground are mainly for resting purposes) will probably drive these men to the Union. For the moment, the main energies of the Union officials are devoted to propaganda work among the employees of Holman Brothers, who are now engaged on munition work on a large scale.

Malaya.—A batch of reports from tin mines in Perak have made their appearance this month. At the Tronoh, a fall in the output is predicted for this year owing to the approaching exhaustion of the best property, but on the other hand bores in a low-grade section indicate that a large extent of ground will be worth treating by bucket-dredge. The yearly reports of Gopeng, Tekka-Taiping, and Penkalen, a précis of which appears elsewhere in this issue, do not take us later than October last, but at the meetings of shareholders the information was brought up to date. At the Gopeng meeting, Mr. Douglas Osborne, one of the managers, stated that the new water-supply had put the company on an excellent basis, and that the costs had been reduced to £23 per ton of concentrate. The area owned is extensive, and in Mr. Osborne's words "it will last longer than some of us young men." The working profit is now about £8000 per month. The Tekka, another of the Gopeng group, produced only 401 tons as compared with 491 the year before, owing to the workings being in unusually heavy ground, but the dividend did not fall much, the amount distributed being £21,000 as compared with £24,000. During the last few months the rate of output has advanced once more.

The Ipoh company is to be congratulated on having escaped from its financial difficulties, which were caused by some shareholders failing to pay their calls. Last year the company had to execute a mortgage on the bucket-dredge in favour of Werf Conrad, the builders. This mortgage was later assumed by the Borneo Co., which also advanced additional working capital. This mortgage has recently been discharged, and the Borneo company has taken shares instead. Dredging operations began in September last, and the company has already been able to distribute an interim dividend.

Canada. — The agreement between the Hollinger and Canadian Mining & Finance companies for the absorption by the former of the Acme and Millerton properties, has been ratified by the shareholders of the various companies. The new company is called the Hollinger Consolidated Gold Mines, with 5,000,000 shares of $5 each. Of these shares, 2,400,000 are allotted to shareholders in the Hollinger, 2,100,000 to Acme shareholders, and 200,000 to Millerton shareholders. Mr. P. A. Robbins, the manager of the Hollinger mine, becomes managing director of the new company. He states that there is no indication of a fall with depth as regards amount or grade of the ore at the Hollinger or Acme, and he speaks of the Millerton as a mine with lower-grade ore, but of great promise.

United States.—As mentioned on several occasions lately, the development in depth of the Alaska Treadwell, Alaska Mexican, and the intervening 700 ft. mine of the Alaska United is exercising the attention of the engineers. The three mines are under the same control and management, but nevertheless the configuration of the orebody at depth, the distribution of the gold, and the methods of mining and hoisting present problems which make the relative valuation of the interests of the three companies extremely difficult. Moreover the assay-values in depth indicate a substantial fall in the grade of the ore, but as a similar fall occurred a thousand feet above, the engineers are by no means discouraged. By the combination method of working the three properties some economies may be expected, but in any case the profit, even on $1·75 ore when 1½ million tons is milled per year, will be fairly respectable. The ore at this big and wide deposit has ranged in assay-value from 7s. to 13s. per ton, and the working cost from 4s. to 8s., so that satisfactory dividends have been paid continuously. The aggregate dividends for 1915 were about two-thirds of those of the year before, and the fall in the average grade of the reserves indicates a continuance of the reduced rate, if not a further reduction. The plan for developing the properties in depth, as outlined a year or two ago, is to leave a solid pillar below the 1750 ft. level and start a new development level at 2100 ft. This work has been in hand for some time. The central shaft of the 700 ft. mine is being used for the development at depth, and No. 2 shaft of the Mexican mine is now being sunk in order to serve as a second shaft for the deep-level work.

The six 'porphyry coppers' have recorded interesting results of their operations in 1915. Of these six companies, it will be recalled that four of them, the Utah Copper, Nevada Consolidated, Ray Consolidated, and Chino are administered under the general direction of Mr. D. C. Jackling. The Guggenheims, or American Smelting & Refining Co., have a large interest in the two first mentioned. Among other important companies, the Inspiration is identified with the Anaconda, and the Miami is controlled by the Lewisohns. The total amount of copper produced by these six companies in 1915 was close to 200,000 tons, of which Utah Copper contributed nearly 75,000 tons. The total value of the copper sold in 1915 by the six companies was $67,480,993, on which the net profit was $39,511,951; the dividends from this being $17,941,450. The cost of putting electrolytic copper on the Atlantic seaboard, including all possible charges such as depreciation, taxes, etc., varied from 7·12 cents per pound in the case of Chino to 9·42 cents for Ray Consolidated. These results are the more remarkable when it is remembered that they were made on extremely low-grade ore, ranging from 1·43% at Utah Copper to 2·17% at Chino. As usual the proportion of copper recovered from the ore was low, being only 64·11% at Ray, the lowest, and 79·95% at Inspiration, the highest. These figures, especially those at the Jackling mines, will be raised by application of the flotation process.

Russia.—The necessity for increasing the stock of gold for the purpose of stabilizing financial relations with other countries is fully recognized by the Russian Government, and everything is to be done to facilitate the expansion of gold-mining operations. With this object in view the import duties on the required mining and prospecting machinery have been suspended for ten years commencing January 1 of this year. Duties already paid since that date are to be refunded.

China.—The sudden death of President Yuan-shi-kai gives a new complexion to Chinese politics. We have already recorded that half the provinces, especially those in the south and west, had revolted against his threatened assumption of the imperial crown. Since our last issue, the provinces of Sze-chuan and Hunan had declared their independence, and the province of Shantung, nearer to Peking, was reported to be in the hands of the rebels. It seems probable that his successor, Li-yuan-hung, will regain the support of the disaffected provinces.

EDITORIAL

IF England is to maintain pre-eminence in manufactures, the workmen must cease their organized slacking, and the trades unions must encourage the individual to reap to the full the benefit of his particular genius. In his presidential address to the members of the Iron & Steel Institute, Sir William Beardmore gave a concrete example of the evil influence of this limitation of effort. In one of his machine shops where shell bodies are made, the actual output by the girls, who are not under the influence of the trades union, is double and sometimes more than double that of the skilled and trained mechanics.

METALLURGISTS and business men should read Mr. J. C. Moulden's voluminous paper on 'Zinc' read before the Royal Society of Arts last month. This paper had previously received the Peter Le Neve Foster prize awarded by the society. Mr. Moulden is a South Australian by birth and he has been connected with the Sulphide Corporation for some years. In the discussion that followed the reading of the paper, the claims and possibilities of electrolytic zinc were emphasized by several users of the metals. We may express the hope that Mr. Moulden will develop the paper into a book, for readily accessible literature relating to the production and metallurgy of zinc is scarce at present.

EVIDENCE relating to the Sudbury copper-nickel deposits adduced by Mr. Cyril W. Knight, as mentioned in our Mining Digest, delivers a disconcerting blow to the magmatic segregation theory. This theory, though simple, experiences many troubles. We are reminded of a geologist who, without seeing a certain deposit, opined that it was a case of magmatic segregation. When told that unfortunately for him the heavy sulphides were at the top instead of the bottom, he was not worried for more than a minute, but developed a new idea on the spot; by combining Mr. Eugene Coste's theory of the inorganic origin of petroleum and the principle of pneumatolysis, he was able to prove, to his own satisfaction at any rate, that concentration by flotation was known in the Pre-Cambrian age.

RADIO-ACTIVE material has often been proposed as a stimulant for plant growth, and some investigators claim to have achieved successful results. The more cautious horticulturists are inclined to be sceptical. Last year we quoted that sound commercial botanist, Mr. Martin Sutton, and gave an outline of his researches and experiments. His general conclusion was that though radium had some effect, equal or better effects could be obtained by the fertilizer known already to suit each particular plant. Since then he has conducted a second series of elaborate experiments, with results of much the same nature. He is disinclined to pursue the subject further.

OUR editorial in May on the manganese position has proved helpful in many quarters. In the present issue we quote an article by Mr. E. C. Harder, describing the manganese deposits of Brazil, to which country the American ironmasters are looking for relief from the awkward position caused by the stoppage of shipments to the United States from the Caucasus and India. Mr. Harder has done much to elucidate the Brazilian ore occurrences, but we must give credit to Mr. Herbert Kilburn Scott for being the first mining engineer to publish any memoir on the subject. His paper presented to the Iron & Steel Institute in 1900 forms the starting point for a study of the Brazilian deposits.

LAST month we recommended mining engineers to pay more attention to the advice of their mechanical and electrical confreres. Miners have a special debt also to railway engineers, who often act as efficient prospectors. The discovery of silver at Cobalt is a much quoted example of ore being disclosed in a railway cutting. It is not so well known that the manganese deposits of Brazil were discovered in a similar way.

BY an error in transcription, a mistake crept into the table of capital issued, output of gold, and value of ore reserve in Mr. Feldtmann's article on the Ashanti gold mines in our last issue. The column of yearly outputs was headed 'oz.' instead of '£.' We believe, however, that, from the context, readers will already have discovered the slip.

SOME people may be surprised to hear that there is a scarcity of diamonds at present. The munition workers are, we regret to say, putting their earnings into jewellery, and stones of the smaller sizes are consequently in demand. The Société Internationale Forestière et Minière du Congo has no difficulty in selling its produce, and indeed it receives many competitive offers. The Congo diamonds are similar in character to those of South-West Africa, and are all of small size. The American demand, also, has become keen lately. The Bultfontein and Wesselton mines of the De Beers company are to be re-opened, and the workings are now being put in order. The Union Government has finally decided to impose the 5% export tax on uncut stones.

RESEARCH is now generally recognized as a first step toward the establishment of technical industries, and in the re-arrangement of the world's trade now taking place and to follow the war there must be much research regarding processes, and many tests of new raw materials. How widely this is understood is called to mind by the passage by the Lower House of the Japanese Parliament of a bill for a National Laboratory for chemical and physical investigations. Perhaps even more significant is the fact that without waiting for government aid, private laboratories, such, for instance, as that of Mr. T. Hasegawa at Tokyo, have been opened for commercial research work. The modernization of Japan was accomplished through government action, the impulse being from above. Later the great families converted themselves into business houses, and feudalism in commerce succeeded feudalism in war and agriculture. New conditions even in an old country bring new opportunities, and now young men trained abroad and experienced in local industries are starting on an individual basis. There is room for the establishment of many new industries in Japan, and the Japanese are evidently disposed to see that their basis is sound.

The Geological Survey's New Work.

The Geological Survey is to be congratulated on the excellent work that is now being undertaken with the object of recording the country's mineral resources. The Survey and the Jermyn Street Museum were established expressly for the purpose of assisting the commercial development and utilization of ores, building stones, and the many other valuable constituents of the earth's crust, but on occasions the criticism has been valid that the science of the Survey was more 'pure' than 'applied.' The same criticism has also been aimed, and with justice, at the Geological Society, where even a hint of commercialism is taboo. It is therefore with unusual satisfaction that we find the Survey devoting its energies to the collection and classification of information that will help the metallurgist and the manufacturer. This information is being published in a series of 'Special Reports on the Mineral Resources of Great Britain.' In our March and May issues, we quoted at some length from the volumes on tungsten and fluorspar. Other volumes already published describe the occurrences and uses of manganese ores, strontianite, and barite. Volumes to appear shortly deal with glass-sands and refractory materials respectively. Subsequently the Survey will devote attention to the ores of iron, lead, zinc, and copper, building stones and paving stones, salt, peat, and the rare earths. We look forward with special interest to the volume on lead ores, for if records were readily accessible to the public, many a mine in the North of England and in Wales that was closed thirty years ago during the severe depression in the price of the metal would now be attractive to the engineer and the capitalist. Dr. Aubrey Strahan and his assistants work under disadvantageous circumstances, for they have so many other calls on their services arising from the war. They would surely welcome the right sort of assistance. We therefore suggest that the staff be recruited from among the many geologists, mining engineers, and mine accountants who are beyond the age limit. The strengthening of the country's trade position and the development of our mineral resources are worthy national objects, and many of our friends would willingly volunteer for the duty. They would feel that their abilities were being better utilized than when they shoulder the rifle or strap the constable's baton round their wrist, and that they were at last doing something really useful. The function of efficient government is to allot to each man the duty for which he is best fitted.

A Corps of Mechanical Engineers.

Not even the most ardent and faithful supporter of the Government will claim that the engineering talent of the country is being fully utilized in forwarding the production of war material. Proposals for reform in this connection have been plentiful, but they usually fail to impress the authorities owing to their vague and general nature and to the absence of definite recommendations. On occasions, however, sound suggestions have been made. One of the most acceptable, because practical, is that of Mr. A. E. Berriman, chief engineer for the Daimler Company, who has circulated his proposals in the technical press and among the members of the engineering societies. Briefly, his suggestion is that a Corps of Mechanical Engineers should be founded and that every qualified engineer and mechanic should be enrolled in it. Their duty would be to help in co-ordinating the manufacture and supply of the Army's requirements. We have a Corps of Royal Engineers who do duty in the field, and an engineering branch in the Navy, but the mechanical engineers have no authoritative standing in the Government or in the Army, and their training and abilities are not utilized in any responsible capacity for the organization of supply. Until the Ministry of Munitions was established, there was no government department for co-ordinating contracts and accelerating output. Even now, the Ministry is a civil department of the State, and the control is in the hands of neither the Army nor the competent engineer. Mr. Berriman gives concrete shape to a thought that has been present in the minds of reformers for many a long day, and we commend his proposals to those in authority. And it seems to us that the advantage of the proposal would not be limited to its excellent immediate effects on the conduct of the war, for the experience gained by each individual in the co-ordination of methods would have an ultimate influence in ordinary commercial engineering. It is not only in connection with war supplies that delays, duplications, and general absence of system exist. In all engineering work in peace times also, the same disadvantages are notorious, and there is a woeful lack of co-operation among the captains of every branch of industry. A move toward unification of methods and standardization of specifications would be immensely assisted after the war by the experience gained by such a Corps of Mechanical Engineers.

The Australian Metal Position.

After having been at the mercy of the exponents of international law for twenty months, the English companies operating at Broken Hill, that is to say, the British Broken Hill Proprietary and the Zinc Corporation, have been released from their German contracts by the Board of Trade, which is empowered to take such action on public grounds under the provisions of the Trading with the Enemy Amendment Act. It might be supposed that, having secured the determination of the contracts, the future course of the two companies would be plain sailing. This is not so, however, for the rules and restrictions recently laid down by the Commonwealth Government are so stringent and even galling, that the companies as business concerns are likely to be severely hampered and their chances of profit-earning practically throttled. The companies indeed seem to have passed from the sway of King Log to that of King Stork. The Commonwealth Government is rightly urging protection of British industries, but drastic reforms and reorganizations sometimes prove to be boomerangs. We would say to Mr. W. M. Hughes: Go slow; take the advice of business men, mine owners, and users of metals: do not rely on lawyers, politicians, and orators; after having freed Australia from the German grip, pause before you forge another set of shackles for the mining industry.

As the regulations now stand, all the base metal products are to be smelted in Australia if possible, and at any rate within the British Empire, France, and Belgium. Consequently, no new contract can be made for the sale of lead or zinc concentrate to such countries as the United States and Japan. The producers of lead concentrate must either join the Broken Hill Associated Smelters, the combine which now owns the Port Pirie plant, or they must erect furnaces of their own. The Port Pirie plant is not able to treat all the ore offered by the present members of the combine, and there is no certainty of the capacity being sufficiently extended within the next year or two to handle the output of all possible customers. As regards new smelters, it may not be convenient for individual companies to raise capital at present, and the permission of the Treasury to do so cannot be taken for granted. The zinc situation is similar, for the Australian Government has decided to form a Zinc Producers' Association with the object of controlling the sale of all zinc concentrate produced throughout the Commonwealth. The conditions, however, are different, in that the smelting of the concentrate cannot be done extensively in Australia, and Mr. Hughes is now engaged in negotiating with the British Government and with metallurgists here for the establishment of a zinc smelter in Great Britain sufficiently large to treat 60% of the Australian output. The remaining 40% of the output is to be smelted in Australia and in the countries of our Allies. Companies not joining this Smelters' Association will have the option of erecting their own works, but here again the raising of capital is a question that requires serious consideration, and the companies would be fully justified in asking the Government for a long term contract for the purchase of the lead and zinc produced before approaching investors and capitalists.

We take this opportunity of urging that every endeavour should be made to harmonize the interests of the Imperial Government, the Australian Government, and the mine-owners. These interests are widely divergent, and the respective points of view are entirely different. The Imperial Government reluctantly and only on compulsion appoints a Commission; and when it does, the members of the Commission usually know nothing of the matter in hand; the Commonwealth Government sees only the claims of labour; and the mine-owners consider that their hard business experience and their financial aid in the development of the riches of the earth should receive full recompense. We have here discussed the new policy in its general bearing on the metal business of Australia. When the authorities publish details explaining how the policy is to be carried out, we shall once more revert to the subject.

Educational Problems in South Africa.

Educational problems are attracting much attention in South Africa, and especially upon the Rand. In a country where white men and black men live side by side, education and training become especially important to the white men. There is nothing sadder than the fate of the poor white, the man who, because of lack of ability, of opportunity, or of industry, fails to maintain himself in the superior position which custom and conditions assign to him. Unable to compete with his fellows, he is even less prepared to come into competition with black men for the rewards of rough labour. The simpler wants of the native give him an economic advantage, which is the undoing of the white man forced to work by his side and for the same reward. Over any long period or wide area the white man can only maintain himself in the superior position by being really superior, and to that end education and training are of first importance. That so many fail to see this and are content to ride on the black man's shoulders, while contributing little or nothing to the economic efficiency of the whole organization, only increases the anxiety of those who are the leaders and who, by virtue of the gift of leadership, carry so much of the burden of every community. South Africa, while an old country, is a new nation. It is scarcely six years since the Union was formed and even South Africans of the fourth generation have only recently had the opportunity of thinking nationally. They are throwing themselves into this with all the energy of a young and pioneer people. On the Rand there is the special incentive that, for a variety of reasons too large for discussion here, the supply of white men available for the mines is decreasing. With 170,000 natives at work in the Rand mines, there are but 21,000 whites. Phthisis scares the overseas miner of experience who would otherwise be attracted by high wages paid, and the same disease, or fear of it, causes many to desert the mines as soon as savings have been accumulated. Fortunately an increasing number of the young men are coming from the Boer farms, forced off the land by repeated subdivision among the sons of large families. They serve a few years, acquire capital for a venture of their own, and return to the land. The Rand as a whole now has a white population of something over 200,000, and from this the mines should draw a much larger number of skilled workmen than has been possible in the past. The high wages paid tempt the young lads into 'blind-alley' occupations before any proper educational foundation for advancement has been laid, with results later harmful both to the lad and the community at large. The more far-seeing Afrikander sons are keenly aware of this, and in the Mines Training School, the Trades School, and the South African School of Mines and Technology, are doing much interesting work, of which we purpose to speak at another time, to meet the situation. Just at present the whole of South African opinion that is not concentrated on the war is keenly concerned with University problems.

Under the Act of Union, higher education is a function of the Union Government. There are a number of existing educational institutions in the various provinces, and the problem of co-ordinating them, and also of how to obtain a truly national university, has been much discussed ever since the Union came into being. Violent interest has been aroused by three University bills introduced in the Assembly by the Minister of Education, and now under discussion. It will be recalled that Alfred Beit left a bequest of £200,000, including the estate of Frankenwald, for the founding of a Transvaal University, with the provision that if the offer was not accepted within ten years, which period closes with July next, the money should revert, being then at the disposal of Mr. Otto Beit. Later Sir Julius Wernher bequeathed £250,000, to which Mr. Otto Beit added £50,000, and the De Beers Consolidated £25,000, for the founding of a National University at Groote Schuur, Cecil Rhodes' old home near Capetown. This was the result of representations made in 1910 by General J. C. Smuts as to the desirability of a truly national residential university, where both the white races of South Africa should unite their work and cultures. With this purpose Johannesburg residents were in deep sympathy, and they readily agreed to give up claim to the Beit bequest in order that this larger purpose might be accomplished. Unfortunately difficulties arose over conflict of interest between an institution at Stellenbosch under Dutch influence and tradition and the South African College at Capetown, similarly representative of the British tradition. Now it is proposed to incorporate both of these under university rank, and to affiliate virtually all the other scattered organizations, including the School of Mines at Johannesburg. Under this plan the title 'University of South Africa' would go to the affiliated schools, but the money from the bequests would go to a glorified South African College, now to become the University of Capetown, at the same time that the Dutch School at Stellenbosch would be given equal rank. At Johannesburg this is felt to be a very different matter from the National University in favour of which it relinquished its claim to the Beit bequest, and it is pointed out that, instead, a distinctly local school is to be benefited. Objection is also made to the plan of a university by loose affiliation of widely scattered colleges as being educationally unworkable. If a local institution is to be favoured it is urged that Johannesburg, as the largest white community in Africa, and the principal source of the money concerned, has strong moral claims for consideration. Legally the project proposed by the Minister is sound, as the original bequest has all but reverted, and its subsequent bestowal is clearly at Mr.

Otto Beit's option. It is also true that to scatter the funds available would defeat the purpose of the bequest, but we confess that the failure to make the new University truly national impresses us as an unworthy concession to political expediency. To find such matters occupying the most prominent position in public discussion, always excepting topics related to the war, speaks volumes for the future of our newest Commonwealth, and we feel confident that, whatever the final fate of the particular bills now under debate, Johannesburg and the Rand will be the gainers educationally. It can hardly remain indefinitely "the only European community of its size in the British Empire that is without means of giving university education to the younger generation." There is too much at stake now and in the future, and public spirit and enterprise are too important.

The Development of Russia's Mineral Resources.

The appeal of the representatives of the Russian Duma, who have recently visited this country, for financial and commercial assistance in the development of their country's vast resources, receives the heartiest sympathy and support among mining men. For a century, in one way and another, mineral deposits in various parts of the Russian Empire have been developed and operated with the help of British capital and imported technical skill. The extent of this interest has been comparatively small, and the more important ventures have been limited to the activities of a few financial groups. The lack of knowledge on our part of the language and the customs of the country, the immense distances and the absence of means of communication, and the difficulties of negotiating with the officials and owners, have all been obstacles in the path of the English venturers. But fellowship in a worthy cause has drawn the two nations together, and the improved mutual relationship will serve to facilitate the establishment of English enterprises throughout the Russian Empire. The financial success of many of the recent Russian ventures should prove an incentive for attracting further British capital.

The time is appropriate for a review of what has already been done. Of the earlier activities, that of John Hughes, who established iron-smelting with coke, was undoubtedly the most important. It is interesting also to note that the Gladstone family has been for many years in control of coal-mining operations in South Russia. The great statesman was always in sympathy with Russia, and had he been in power in 1878 the present position at the Bosphorus and the Dardanelles might have been different. But in the early days the mining enterprises did not come much before the public, being mostly imperial or private commercial businesses, and it was not until the eighties and nineties that British and American houses began to take a general interest in the mineral resources of Russia. Special attention was then paid to the gold gravels, and many well known engineers made examinations. This was in the days prior to the completion of the Trans-Siberian railway, and the conditions with regard to communications were such as to discourage any large placing of capital in Siberian mines. The modern activities known on the Stock Exchange were set rolling by Mr. Ernest Terah Hooley, whose career as a promoter was as brilliant and brief as that of the proverbial rocket. In 1900 he floated the Siberian Goldfields Development Co. for the purpose of working alluvial properties in Nerchinsk, Eastern Siberia, which proved unprofitable. Mr. Arthur L. Pearse, whose advice had been sought, recommended the acquirement of a lode property. The name of the company was then changed to the Nerchinsk Gold Mining Co. which developed and equipped a mine that was later sold to a subsidiary, the Kluchi Gold Mines Limited. No dividends, however, were ever paid, and both companies were dissolved at the end of 1911. Though the gravel property of the Siberian Goldfields proved a dismal failure, it served to fix the attention of the public and the mining houses on the Russian Empire as a field for speculative enterprise. Mr. Hyman Orkin brought the Spassky group of copper properties in the Akmolinsk province to London in 1902, and with the aid of Mr. Arthur Fell, the Siberian Syndicate was formed to float them. By the co-operation of L. Ehrlich & Co., and a French group, the property was floated in

1904 as the Spassky Copper Mine Ltd. The reorganization of the mining methods and the initial expansion of smelting operations were in the hands of Messrs. W. Pellew-Harvey and E. Nelson Fell, and later, Mr. E. T. McCarthy has been consulting engineer, and Mr. H. C. Woolmer has been in charge. The Yuspenssky mine has been the important producer of the group, and has yielded profits from rich but limited ore-shoots. The concentration by flotation of the lower-grade ores is now in hand. In 1906 the Siberian Syndicate also promoted the Atbasar Copper Fields Limited, to develop a copper deposit in the Kirghese steppes. In 1911 Messrs. H. C. Hoover and A. Chester Beatty took a financial interest, and Messrs. R. Gilman Brown and Walter G. Perkins studied the mining and metallurgical problems on their behalf. Their interest, however, did not continue, and since then the Spassky has assumed the financial requirements of the Atbasar, finally in 1913 absorbing the whole undertaking.

In 1905 Mr. Hyman Orkin again appeared on the scene and introduced two gold-mining properties. He had obtained the necessary financial support of another group, and the Siberian Proprietary Mines Limited was formed for the purpose of financing the flotation of the properties. These two properties are situated in Orenburg province, in the southern Urals. They were handed over to two subsidiaries, the Troitzk Goldfields Limited, and the Orsk Goldfields Limited, with Messrs. Hooper & Speak as technical advisers. The Orsk property soon proved to be valueless, and the company proceded to look for another mine. Eventually the Kolchan alluvial gold deposit near Nicolaievsk, in the Ochotsk province of far east Siberia, was acquired from the Russian Mining Corporation, a company of which we speak in a succeeding paragraph. It was Mr. C. W. Purington who originally saw the possibilities of the Kolchan property. The delivery of the dredge built for this property by the New York Engineering Company was delayed by a steamer collision on its outward voyage, which event resulted in the missing of an entire season and causing a greatly increased expense before it was finally erected. During this period Mr. Purington, and subsequently Mr. D'Arcy Weatherbe, operated the nearby Pokrofsky gravels by means of a stacker-scow, later converted into a dredge. For some years the business of the company has been made difficult by lack of capital, and it is only lately that the two dredges have been able to earn a divisible profit.

The Russian Mining Corporation was formed in 1906 as a subsidiary of Mr. F. W. Baker's Venture Corporation, which had in earlier years floated Stratton's Independence and the Camp Bird mines. In the Russian enterprise, Mr. Baker had the co-operation of the Consolidated Gold Fields of South Africa and Consolidated Mines Selection, the latter being represented on the board by Mr. Walter McDermott. As already mentioned, the company sold a property to the Orsk Goldfields, but the great stroke of business was the purchase of a majority of the shares in the Lenskoie company, which owns extremely rich gold gravels near Bodaibo, on the Vitim and other tributaries of the Lena. These shares were acquired by the Lena Goldfields, a company formed in 1908 for the purpose. The function of the latter company has proved to be one rather of finance than of technical direction, for the management has remained in the hands of the Russians, and the company's consulting engineers, first Mr. C. M. Rolker, and latterly Mr. C. W. Purington, have not had as great a say in matters of policy as they and we would have desired. During the last year or two the Russian Mining Corporation has once more become active, and with Mr. J. P. Hutchins as engineer, has examined many properties, and has acquired in particular the mining rights on the Zerianovsk and Sminogorsk complex-sulphide deposits in the Altai adjoining the Ridder. Mr. E. D. McDermott is in charge of the development work at these mines. The Corporation has also acquired an interest in the Russian Anthracite Collieries Ltd., Southern Russia.

The creation of another important group of enterprises is due to the energies and influence of Mr. Leslie Urquhart, a Scotsman with long personal experience in Russia. In 1906 he introduced the Kyshtim Estate in the Urals to the notice of controllers of capital in London, who formed the Perm Corporation for the purpose of conducting the negotiations. After Mr. H. H. Knox had made a preliminary examination, the corporation formed the Kyshtim Corporation for the purpose of acquiring the whole of the share capital of the Russian company, thus securing full control of the copper-gold mines, iron works, and forests. It was found necessary to completely reorganize the original British company in 1910, and at this critical juncture Mr. H. C. Hoover lent his aid. For the re-modelling of the metallurgical plant, the expansion of mining operations, the exploration of the orebodies, and the provision of adequate working capital, the shareholders have to thank Messrs. H. C. Hoover, R. Gilman Brown, and Walter G. Perkins. The normal output of the plant is now 10,000 tons of copper per year, though of course the war conditions do not permit this figure to be realized at present. The controllers of the Kyshtim floated the Tanalyk Corporation, which was formed in 1912 to acquire the shares of a Russian company owning copper mines in the Southern Urals. Gold deposits have also been developed on the estate. The war has interfered with the expansion of this enterprise, but prosperity is only delayed.

The Anglo-Siberian Co., which was instrumental in guiding the Kyshtim and Tanalyk through the initial stages of organization, was liquidated, and in 1912, with the remaining cash assets, Messrs. Hoover and Urquhart formed the Russo-Asiatic Corporation with a view to acquiring one or more lead and zinc deposits. The Ridder mines in the Altai and the Kadainsky in the Nerchinsk district were taken under option, with the Ekibastus coal property, within easy reach of the Ridder. The examination of the Ridder and Ekibastus gave such satisfactory results that the Irtysh Corporation was formed toward the end of 1914 to operate them. That no time has been lost by the engineers may be judged from the fact that the zinc smelter designed and erected by Mr. T. J. Jones is now ready to commence work.

Of other Russian enterprises that have been prominently before the public recently, the Sissert deserves mention. This company was formed in 1912 to acquire mines and an estate in the Urals, not far from Kyshtim. These mines had been successfully worked under the management of the late August Hofmann for many years. Of the various mines acquired, only the Sysselsky has reserves of ore, and these are of not so great an extent as is desirable for a London company. Attention is now being directed to other parts of the estate, and in particular to the Degtiarsky, where bore-holes are proving extensive deposits of copper ore.

We conclude our review of Russian mining operations at this point, though we are aware that many other enterprises in the past and currently deserve mention. A few general observations may, however, be timely. We would remind readers that the companies now operating are greatly hindered by the want of workmen, owing to the demands of the war, and that the difficulties of exchange prevent the transmission of profits to this country. Any future expansion of interest in Russia and Siberia must necessarily wait until the end of the war. The ultimate control between British and Russian interests is a question that has arisen, and will subsequently form an increasingly important factor in future negotiations; but we believe that a reasonable attitude, on the one side of British financiers and engineers, and on the other of Russian owners and engineers, will solve all the difficulties. Our own opinion is that English companies will be most effective if they hold permanently the control of the shares in the Russian companies, and at the same time use to the fullest the local engineering and administrative talent. One word of caution, however, must be given to the Russian authorities. They must appreciate that the risks attendant upon mining ventures are sufficiently great without the mines being saddled with heavy taxation of profits. Until definite guarantees can be made of future policy with regard to taxation, it will be difficult to secure large investments of British capital. The Russian Government is already aware of the necessity for treating mine operators liberally, as is evidenced by the recent suspension of import duties on gold-mining machinery, and this sympathetic attitude will, we feel sure, be extended to the matter of taxation.

THE MINERAL RESOURCES OF URUGUAY

By ROLF MARSTRANDER.

The Republic of Uruguay is little known as a possible producer of metals and minerals. The mineral resources, at present known, are not of great economic importance, but the author's records will prove useful to future prospectors and investigators.

IT is seldom that anything is seen in the mining papers relating to Uruguay, and to most of the men in our profession the country is practically unknown, both as to its geological features and mineral resources. The fact is that Uruguay is one of the least explored countries in South America, and it is only recently that attention has been paid to it. Records of the mineral occurrences consist solely of scattered narratives in periodicals of various countries. There are no native geologists or mining engineers and almost the entire work of exploration and inquiry has been done until lately by outsiders. During the last few years, however, a change has been made, and it seems that the people of the country have come to desire some knowledge of its soil and the riches it contains. Prof. K. Walther, of the Instituto Nacional de Agronomia, has been active with this object in view for some time, and three years ago the Instituto de Geologia y Perforaciones, under the direction of Dr. M. A. Lamme, of Columbia University, was created with the object of giving an impetus to the mining industry. It is hoped that the systematic exploration of the Republic has thereby been placed on a secure footing.

GEOLOGY.—The country lies between the southern Brazilian formations of granites, metamorphic schists, and Gondwanaland series, and the eastern Argentine formations consisting of Tertiary and Quaternary deposits, or Pampas formation. Most of the country is flat or slightly undulating, bare of forests but covered with a rich pasture. The eastern part is, however, more mountainous. The mountains form the famous Cuchilla Grande, the main axis in the orography of the Republic, and they, together with the branches, contain the most important mineral deposits of the country. The mountains are not a 'cuchilla' or ridge in the real sense of the term, but more nearly approach an irregular agglomeration of rolling hills and small ridges, some of them being entirely covered by vegetation, while others have barren slopes and tops.

The Cuchilla Grande has a general direction of north-northeast, parallel to the coast, and consists of granites and gneisses accompanied by older metamorphic schists. The ridge forms one of the southern extremities of the Brazilian granite and is a continuation of the Sierra do Herval granite in Rio Grande do Sul. A similar ridge is also found along the southern coast up to the Rio Uruguay, though it is much less prominent, having fewer outcrops and not being so continuous as the former. The same is true to a still greater degree in the north where smaller and more isolated granite ridges extend westward. Among these may be mentioned the Sierra de Aceguá, and the Sierra de los Cerros Blancos.

The metamorphic schists, which, with rare exceptions, accompany the granites in all places, and which have been elevated, folded, and faulted by them and subsequently denuded, have generally suffered little from metamorphism, for shales are found with mica schist and dense limestone with marble. The degree of crystallization, as will be easily understood, depends in most cases on the distance from the eruptive rock and the special local influences to which the rocks have been subjected during the mountain movements. This series of metamorphic schists is extraordinarily rich in limestone and dolomite, and layers of bituminous shales, graphitic beds, and talc schists are also noteworthy. No fossils have as yet been found, but we may safely place the schist as pre-Devonian.

These formations of granite and schists constitute the frame-work of the country and form, with rare exceptions, its most elevated portions. The vast plains and undulating regions resting, so to speak, in a basin of this frame, occupy the central and littoral parts of the country and consist for the greater part of nearly horizontal layers of younger sedimentary rocks, intercalated in some places with lavas. These sedimentary rocks may conveniently be divided into three groups, beginning from below:

(1) The Santa Catharina system of rocks, named from the state of Santa Catharina in Southern Brazil where it was first studied and considered equivalent to the Gondwanaland formations of South Africa, India, etc. The two lowest members in this system are

the Tubarão and Passa Dois groups, or the proper Gondwana. The Passa Dois is, in places, separated from the third and highest group, the São Bento series, by an unconformity. This last is considered of Triassic age.

(2) Tertiary rocks.

(3) Quaternary rocks and sediments, the Pampas formation.

As to the distribution of each of these formations in Uruguay, it is inadvisable to undertake any classification with our present knowledge, and what I give in the following paragraphs is intended as a rough sketch only.

The Santa Catharina system, consisting of shales, sandstones, limestones, and diabases, is found in the northern and eastern parts of the country overlying the granite and crystalline schist base. The lower series are found farther northeast in the departments of Rivera and Cerro Largo near the Brazilian frontier. This is proved by the fact that I found a Permian reptile, the *Mesosaurus Brasiliensis*, belonging to the lower part of the Passa Dois series, the Iraty Black Shales, 10 miles south of the border in Cerro Largo. These shales cover wide districts in Cerro Largo, and are also frequently seen in the department of Rivera, to the west. As a rule, the layers have a gentle dip south-southwest, and they are distinguished by vast plains and undulating regions from which the granites protrude like islands. According to the dip, which is constant, younger rocks should be found to the south passing into the lower part of the São Bento, and this is virtually the condition that exists. How far to the south the Santa Catharina system extends cannot be said with certainty. It has been assumed, however, by Dr. Walther that it reaches near to the southern coast, in the department of Canelones.

To the northwest, in the departments of Rivera, Artigas, Salto, and Tacuarembó, the highest groups in the São Bento series occur, consisting of great thicknesses of grey and red sandstones, partly intercalated, partly covered, by vast sheets of diabases and melaphyres. In the last named rocks are found the well known Uruguayan agates and amethysts. In several places in these departments the massive sandstones with the intercalated basaltic sheets rise above the surrounding plains forming large monadnocks or mesetas, as they are called here, with flat and nearly inaccessible tops.

The Tertiary rocks occur in the western and southwestern departments along the lower course of the Rio Uruguay, and are continuous with the Tertiary formation of Entre Rios in Argentina. They rest in some places directly on the granite floor, the lowest part consisting of a coarse basal conglomerate. This part of the country is almost flat and very few outcrops are found. It has therefore not attracted the attention of geologists, as have the eastern parts of the Republic.

The Quaternary deposits form vast layers of marl and brown clays covering all the low plains in central, western, and southern Uruguay. They reach a thickness of 50 metres in places and rest on granites, Tertiary beds, or rocks of the Santa Catharina system. In the lowest part many concretions and irregular bands of hard, clayey lime, the so-called 'tosca,' are found.

All these sedimentary rocks have suffered little from mountain movements. The Santa Catharina system has been cut by faults in many places and probably, through a large flexure, passes over into the central plains. Generally, however, the dip is gentle and undulating over large regions. The Tertiary rocks, in those places where they have been seen, have suffered practically no disturbance.

MINERAL DEPOSITS. — The sedimentary rocks are nearly barren of metals, possessing the least favourable conditions for mineral deposition, and, moreover, they are for the most part concealed under large overburdens. The probability of finding oil or coal in these rocks will be discussed later. As may be easily understood, the majority of the mineral deposits are found in the regions of granite and crystalline schists, that is, those of eastern, southern, and northern Uruguay. This is especially true to the southeast in the department of Minas, where it appears that the southern and eastern granite ridges have met and the most violent structural movements have taken place.

A real mining industry has never existed in Uruguay, nor does it exist now. Mining operations must have been more active in the time of the Spaniards than now, taking into consideration the extensive workings of those times. During the long fight for independence, and in the hundred years of more or less tranquil development, mineral riches did not occupy the thoughts of the people. Only lately, due to the rapid development of the Republic and the general competition of nations, has attention been directed toward minerals, and steps been taken by the Government which will probably act as a stimulus to the new industry.

The causes which, up to the present, have placed the mining industry in such bad straits, may be ascribed to the following:

(1) A heavy overburden hampering the discovery of minerals even in those places where favourable conditions exist.

(2) Little interest in and small knowledge of mining and consequently a lack of competent men to undertake the exploitation. No instruction in mining and allied subjects is given in Uruguay.

(3) Poor means of transport. The railway freights are high, and there are few usable roads and bridges in the country.

(4) Lack of power resources such as coal, petroleum, and waterfalls. Some small falls exist, and in some cases may be utilized.

Some of these obstacles can be overcome, and the present Government is devoting special attention to them. A law has recently been passed granting duty-free importation of mining machinery and implements for mines under exploitation. The mining code is to be revised soon by a committee headed by Dr. Eduardo Acevedo, ex-minister of Industries, a liberal and unprejudiced man extremely interested in the development of the mining industry of the country.

At present only one metal mine is being worked, one talc mine is in operation, and granite and limestones are being taken from a number of quarries. Many large mineral deposits, however, are scattered over the Republic.

As is the case in all new countries, it is the precious and semi-precious metals that have first attracted attention, the base metals and non-metallic minerals only coming into systematic exploitation when the State has settled down and means of communication have been established. Most of the abandoned mines in Uruguay show this to be the case. Of abandoned gold, gold-copper, and lead-silver mines there are a number; for instance, the Santa Ernestina, Curtume, Blixen, Lorenzo Latorre, Zapucay, and Corrales gold mines in the department of Rivera, the Soldado gold and copper mine in the department of Minas, the old gold workings at the Cerro Señora del Carmen in the same department, the copper gold mine La Oriental in the department of Maldonado, the lead-silver mines La Valencia and Ramallo in the department of Minas, and a number of places where prospecting has been done for these same metals. As a proof of this search for gold, it will suffice to state that in the department of Rivera alone more than 300 claims for gold have been registered. Most of these do not amount to much, but I will venture to say after having made a short reconnaissance of this department, that there are good chances of an extensive gold-bearing zone being found.

GOLD AND COPPER.—The only metal mine worked at present in Uruguay was owned by an English company, the Uruguay Consolidated Gold Mines, Ltd. The mine is situated at Corrales, department of Rivera. The ore is hauled by an aerial tramway 6 miles long to the mill on the Cuñapirú river, which is capable of furnishing 1800 hp. to the plant. Work was first started in 1880, but the mine has changed hands a number of times. At present the proprietors are Messrs. Bell and Bowen. At Zapucay, 25 miles distant, this firm has another mine which was formerly worked by the Uruguay Gold Fields, Ltd.

At Corrales there are two vertical parallel quartz veins separated by about 50 ft., and each vein varies in thickness from 20 to 50 ft. From 1894 to 1908 the average yearly yield was 5·7 dwt. per ton, and the largest production was in 1908 when 25,000 tons was treated. The lowest yearly yield during the same period was 2·4 dwt. and the highest 9·2 dwt. per ton. In the first years of work, that is, from 1885 to 1887, the extraction was greater, owing to the fact that rich free-milling ore from the surface was mined. During these years the yield was 12, 15·5, and 10 dwt. per ton respectively. The gold is associated with 30 to 40% of its weight of silver. At present little work is being done, ore being taken from open-cuts only, as the mine is filled with water to the level of the drainage adit. The deepest level of the mine is 230 ft. below adit. The plant includes 2 rock-breakers, 60 stamps, 2 tube-mills, 12 amalgamators, 2 cones, and 6 cyanide vats of 30 tons capacity each.

The gold-copper mines of Soldado, 30 miles northwest of the town of Minas, were first worked by the Spaniards, and subsequently by Uruguayans. Work stopped in 1910, owing to the lack of capital and competent men. The ore is found in numerous steep and narrow veins, partly of quartz and partly of copper-bearing minerals. The deepest level is at 130 ft., and the longest drift is 480 feet. Reports issued by the last operators showed that the ore averaged as much as 4 oz. gold and 40% copper. The average yield was 3·8 dwt. gold and 8% of copper. The principal vein, the Veta Antigua, widens with depth, attaining a maximum thickness of 2 ft. at the bottom of the mine. The ore is most probably the result of sulphide enrichment, a fact that should be kept in mind in future work on this deposit. A great quantity of water comes into the mine, and it is at present full to the 55 ft. level. A small mill was built, comprising 1 Dodge crusher, 1 Lane mill, 1 Wilfley table and 1 cupola furnace.

The copper mine, La Oriental, 20 miles south of Minas in the department of Maldonado, was worked by the Spaniards and then by Uruguayans, but it has been idle during the last 30 years. It is said that there are three steep parallel veins having a width of 2½, 6½, and 6 ft. respectively. The ore consists of pyrite, chalcopyrite, and a little bornite, the average assay being 8 to 10% copper and a small amount of gold. The haulage adit has a length of 1185 ft., and the workings are in good condition. After the outbreak of the war, negotiations for the sale of the mine were made with an American company, and according to owner's statement a price of £26,000 had been agreed. For some reason or other the bargain was not completed.

LEAD AND SILVER are of little importance in Uruguay, and with the exception of the Corrales mine have been found only in the department of Minas. The old Valencia and Ramallo mines, 10 miles south of Minas, have been abandoned for a long time. The Valencia was worked along a narrow quartz vein through limestone. The mineralization is irregular and the mineral-bearing part of the vein does not much exceed a foot in width. Some thin leaders and scattered impregnations are found in the limestone. There is a narrow open-cut 150 ft. long, a short prospecting drift, and several pits and cuts.

The Ramallo mine is half-a-mile south of the Valencia. Here the galena is in bunches and lenses in quartz veins passing through crystalline schists. The greatest thickness of ore observed was 1½ ft. There are two shafts connected by a drift at the 75 ft. level, and the mine is filled with water up to this point. Nearby are an ancient smelting plant and a large dump, which indicate that the deposit was regularly worked at one time. The mineralization is poor and irregular, but the galena is said to be rich in silver. Work was stopped in 1900 at Ramallo and in 1868 at Valencia.

IRON AND MANGANESE minerals are the only ones that are plentiful in Uruguay. With the present state of the transport conditions few if any of the deposits can be worked. Large quantities of micaceous hematite are found at the source of the Santa Lucia river, department of Minas, 15 miles north of the city of Minas. This deposit has never been prospected or studied in detail. The same is true of the deposit known as La Piedra del Gigante, 25 miles east of the city of Minas. Here a mixture of hematite or magnetite is found, cutting through the crystalline schists and outcropping for a distance of 3500 ft. The gangue is a bluish quartz, and the width of the vein varies from 12 to 30 ft. In some places the ore is of high grade, containing 66% of iron, and only negligible quantities of phosphorus and sulphur. In others it is mixed more or less with quartz, which may at times become the dominant mineral. Veins similar to this have been found elsewhere in the same district. The largest deposits are found, however, to the north in the department of Rivera. Here the iron minerals, unlike those found in the department of Minas, all contain or are associated with manganese.

The deposits at Zapucay, owned by the Uruguay Manganese Company, are the best known of the iron-manganese deposits in Rivera. They are found near the southern boundary of the department, and are about 40 miles from the nearest railway. The ore is a mixture of magnetite and psilomelane, and has the following average percentage composition: Iron 35, manganese 23, silica 9, sulphur 0·05, phosphorus 0·03.

The orebody forms two entire hills, and it has been estimated that at least 80 million tons can be mined by open-cut. Much development has been done, but the mines have never been worked. The transport of the ore to Montevideo, which at present is the only port, would mean a haul of more than 300 miles. Taking into consideration the high cost of carriage and the fact that it would be necessary to construct 25 miles of rails to bring the mine into communication with the main railway, it is evident that the deposits cannot be worked at present. Even if the railway should reduce the present rates for ore to those for stone, a reduction of more than two-thirds, the ore would not bring much more than 6 shillings per ton at the mine.

During a reconnaissance of the northern part of the Republic made in December of last year, I found a large deposit of similar ore at Caraguatá in the eastern part of the department of Rivera. The main portion of the deposit is in the Cerro Caraguatá, where the ore outcrops for more than 3500 ft., and is more than 300 ft. wide. The ore is fairly pure, but is mixed with quartz in many places. Three hundred feet to the south is another orebody with an outcrop 1900 ft. long and 65 ft. wide. This ore is also a mixture of magnetite and manganese, but in places it contains much quartz. About 1900 ft. still further to the south is a third lode which is parallel with the others; but here the ore is poor, and in places quartz predominates. About 1500 ft. west of these deposits is another large outcrop, 600 ft. long and 160 ft. wide, which consists entirely of iron-manganese ore. It was not possible to see the rocks lying between these various orebodies, and no opinion could be formed as to their relation. I consider it probable, however, that the ore has a great lateral extension, as small isolated outcrops are found here and there, often at great distances from the main orebody, consisting of similar ore. That there exists a vast mineral zone here is, at least, certain.

About three miles east of Cerro Caraguatá there is another lode of fairly pure iron-manganese ore. Its strike is east-west, as is the case with the others, and it seems to lie in the same stratigraphical horizon as those of Caraguatá. Three miles farther on, there is another large outcrop which consists for the most part of magnetite and quartz. The average content of iron was assumed to be from 35 to 40%. Large outcrops of similar deposits were also found during my visit of inspection at Coronilla, 10 miles east of Caraguatá.

The transport facilities here are even worse than those of the Zapucay district, the nearest railway being 55 miles distant. A new railroad might be built from San Fructuoso, department of Tacuarembó, eastward to Melo, department of Cerro Largo, and from there to the Laguna Merim, which is connected by water with the Brazilian port of Rio Grande do Sul. Such a line would tap the gold mines of Cuñapirú and Corrales, the gold and iron-manganese mines of Zapucay, the iron-manganese mines of Caraguatá and Coronilla, and probably the oil-shale deposits of Cañada de los Burros in Cerro Largo. The entire length of such a railway would be 200 miles, and it would connect two of the existing main lines, a need that is becoming more pressing every day. If this new line were built the distance from Caraguatá to Laguna Merim would be about 120 miles, and from Zapucay to the same point about 140 miles. The only means of carrying goods available at present is by ox carts, and the charge averages 1s. 11d. per ton-kilometre. Any one who has travelled through these districts and experienced the difficulties of the present methods of transport will easily appreciate the need of a railway, not only for mining purposes but to a still greater degree for the agricultural and cattle-raising industries.

Among other deposits of manganese, mention should be made of that of Carrasco, 10 miles east of Montevideo. This orebody has a length of 460 ft. and a width in some places of 150 ft., and the ore contains about 35% of manganese.

OTHER MINERALS.—At Conchillas, in the department of Colonia, a deposit of high-grade talc is being worked by Manuel Narancio, of Montevideo. The mine has been in operation since 1907 and about 8000 tons has been extracted. The mineral is air-dried on large tables and then ground to 200-mesh in a disintegrator. The greater part of the product goes to Buenos Aires, where it brings a price of 56s. per ton.

A large deposit of emery occurs at Cerro Redondo, 4 miles from the town of Minas. It occupies the larger part of a conical hill about 190 ft. high and 460 ft. in diameter at the base. The mineral is found in varying qualities from impure emery schist to emery.

Petroleum and coal have not been discovered on any economic scale as yet, but there are probabilities that they may be found in the northern departments in the Santa Catharina system of rocks. In southern Brazil the only important coal seam is the Jeronimo coal, which occurs with regularity from Irapuá in Rio Grande do Sul to Candiota on the Uruguayan frontier, or over a distance of 250 miles. The coal seam, including the partings, has a thickness of from 3 to 16 ft. There is a probability that this Jeronimo coal-seam extends into Uruguay. It should be remembered, however, that this Jeronimo coal contains 30% of ash and from 5 to 10% of sulphur. Under these circumstances, the coal would have to be broken, washed and briquetted before it could be placed on the market. The discovery of suitable coal deposits in Uruguay would provide a great stimulus to industrial development. Consequently the Institute of Geology has undertaken a systematic study in the northern departments, and drilling operations will be started as soon as the preliminary studies have been concluded.

In regard to oil, our knowledge is even more vague, and the results of the studies are not sufficiently definite to warrant an opinion. In Rio Grande do Sul several bore-holes have been sunk, and it is said that gas, saline waters, and oil-shales were found during the boring.

A little south of the Brazilian frontier, at Cañada de los Burros, and at Paso del Minuano on the river Yaguaron, outcrops of these shales occur, and I have made a personal examination of them. They are black and fine-grained, and weather to a bluish-grey. On fresh fracture they give a strong odour of hydrocarbons, and where pits have been sunk these hydrocarbons quickly gather and form a film on the surface of the water. Thrown on the fire the shales burn with a smoky flame. These rocks occur over large areas, having been observed in various places in the departments of Cerro Largo and Rivera. Their stratigraphic horizon is the Iraty Black Shales, which form the base of the Passa Dois series of the Permian age. An idea of the composition of the shales may be had from the following analysis: Fixed carbon 6·6%, mineral oil 8·7% (sp. gr. at 28°, 0·912), gas (calorific power 6000 calories per cubic metre) 2·5%, sulphur 4·0. During my last trip to these deposits, five tons of the shale was taken out with the object of making tests on a large scale to determine their industrial value. These shales have been considered to constitute the real oil horizon of the Santa Catharina system.

New South Wales Minerals.

The output of gold during 1915 was 132,498 oz. valued at £562,819, an increase of £33,946 as compared with 1914. This is the first time for a dozen years that the yield has shown an increase over a previous year. The net value of the lead and silver produced was £4,432,670, which is £199,410 less than in 1914, and £1,289,184 less than in 1913. The amount of zinc as spelter and as concentrate was 190,915 tons valued at £1,111,569, a decrease of 168,395 tons, but an increase of £90,858 in value. The value of the copper produced is estimated at £234,437, a decrease of £40,234, and the lowest return since 1896. The Port Kembla electrolytic refinery had an output of 20,733 tons, but most of this came from Queensland and Tasmania. The tin produced during the year was worth £266,270.

THE NATURE OF NIGERIAN TIN DEPOSITS

By H. E. NICHOLLS.

The author discusses the modes of occurrence of cassiterite in Nigeria. He gives examples of deposits derived from the weathering of granite, as on the Delimi River, and of deposits derived from the weathering of lodes, as at Leruie-in-Kano. He does not agree with the view that the alluvial deposits are of a secondary nature.

THESE notes are based on observations made during an extended experience in the Nigerian tin field. Although I am personally familiar with the majority of the deposits so far discovered, I do not wish that any opinions expressed here should be taken otherwise than as broad conclusions drawn from a knowledge of those deposits with which I have been brought more intimately into contact.

The deposits may be said to fall naturally under four headings:

(1) Those derived from the weathering of granite in which cassiterite formed an original constituent: (*a*) alluvial deposits, (*b*) eluvial or detrital deposits.

(2) Those derived from the weathering of stockworks and lodes; also divided into (*a*) and (*b*) as in (1).

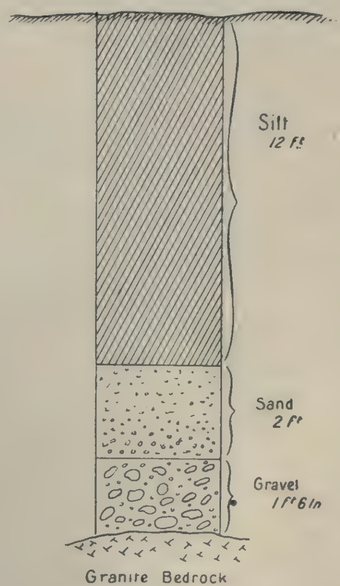
(3) Tin-bearing greisen *in situ.*

(4) Lodes.

There appears to be an impression that the alluvial deposits are of a secondary nature; that is to say, those found at the present time are the products of the re-concentration of deposits of greater age. Personally, I have been unable to find any evidence to substantiate such a theory, and I am of the opinion that the deposits are not only essentially recent, but also that denudation of the primary source of the cassiterite is still in progress. In many instances shed tin associated with topaz can be found lying on the bare granite outcrops, and being brought down in gutters after heavy rains, while, in the streams themselves, fragments of granite with unworn crystals of cassiterite still adhering are not uncommon.

DEPOSITS DERIVED FROM WEATHERING OF GRANITE.—As an instance of deposits falling under the first heading, those situated near the head-waters of the Delimi river may be cited. The Delimi has proved to be one of the richest, if not the richest, river in Nigeria. It flows through granite country, which even at the present time is shedding tin in appreciable quantities. The characteristic features of the river are rocky gorges opening out in places to flats of more or less extensive area. The river itself has proved to be exceedingly rich, while its immediate banks and flats have yielded and will continue to yield large quantities of tin. The deposits themselves are typically alluvial, and yet they present many features of interest. Broadly described, they consist of an overburden of river silt covering a gravel varying in thickness from 6 inches to 4 feet.

In many cases old river channels pursue a devious route through these flats, and in almost every instance are extremely rich. True gravel appears to be almost entirely confined to these



SECTION OF DEPOSITS ON THE DELIMI.

channels, the remainder of the deposits although rich in tin being composed almost entirely of sand. A natural explanation of this is the absence of quartz in any appreciable quantity in the granites which are the source of the alluvium. A curious feature is that when quartz stringers do occur they are barren, which would indicate that the quartz has been deposited subsequently.

The tin is almost entirely confined to the gravels and sands. The overburden, although not barren, carries inappreciable quantities

WORKING THE TIN DEPOSITS ON THE HEAD WATERS OF THE DELIMI RIVER.

of cassiterite, which is usually associated with ilmenite.

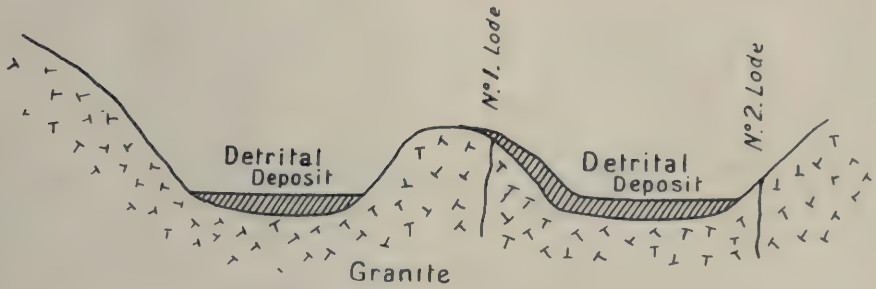
The concentrate is of exceptional purity, and a shipping product of 74% to 75% metal is the rule rather than the exception. Intimately associated with the richness of the deposits is the occurrence of topaz. Wherever the latter mineral is found in quantity, favourable results can almost invariably be anticipated.

Deposits of detrital, that is, eluvial origin, are not uncommon, and although on the whole shallower than in the case of the alluvial deposits, are nevertheless rich and of equal if not greater importance. The origin of these deposits is the weathering of tin-bearing granites *in situ*. Instead, however, of the tin being wholly concentrated in the gravel and sand in the immediate vicinity of bedrock, it occurs throughout the deposits, but with a tendency to enrichment at the bottom. This enrichment would appear to be brought about by the channelling action of heavy rains which, escaping by following the junction of the already weathering ground and bedrock, carry away a certain amount of sand and clay; subsequently subsidence of the deposits occurs, during which the heavier tin naturally finds its way downward with more rapidity than the lighter constituents.

DEPOSITS DERIVED FROM WEATHERING OF LODES AND STOCKWORKS. — The most marked example of deposits falling under the second heading are those of Leruie-in-Kano. Leruie is situated 3200 ft. above sea-level, on a miniature plateau which rises abruptly from the plains, while the main deposits are surrounded with hills rising to a height of 5000 ft. From the surface to bedrock the deposits average 16 feet, and they are partly detrital and partly of alluvial origin, the latter having been formed by the action of an old river channel which at one time passed through it. In the detrital, which forms the major portion, the cassiterite is found scattered throughout the depth of the ground, but with a tendency to concentration near bedrock, while the alluvial carries the usual features of a marked concentration in the gravel itself.

A curious feature of the deposit is its vesicular nature, due to the fact that, while in the rainy seasons the ground is water-logged, in the dry weather the water drains away through numerous channels carrying with it quantities of sand and silt. In course of time the deposit has assumed a sponge-like form, being full of small holes and channels. As a result of this and contrary to the general rule, ground can be placed in a sample box of less cubic capacity than it occupies *in situ*, which fact plays an important part in sampling.

There is no question as to the origin of the cassiterite in these deposits, as not only have lodes and stockworks been discovered, but in the actual prospecting pits stringers of tin-bearing quartz have been found in the decom-



SECTION OF DEPOSITS AT LERUIE-IN-KANO.

posed granite bedrock, and wherever float quartz is found it is almost invariably tin-bearing. The accompanying section will give a clearer idea of the main features of the deposit. It will be seen that the chief zone of mineralization lies between the Nos. 1 and 2 lodes. The so-called No. 2 lode is really a large stringer in a stockwork, while the country surrounding it is full of small veins and impregnations. This main stringer is rich in tin and varies from 3 in. to a foot in thickness. Following the slope of the hill the granite is covered with detrital matter which is clearly derived from the No. 2 lode and its attendant stockworks.

The deposit consists of a mass of angular quartz and fragments of the country, which have been re-cemented by the agency of oxide of iron, the result of the weathering of the micas and ferruginous portions of the stockwork itself, and is so hard that it can only be broken by blasting. The cassiterite which occurs scattered throughout is coarse, and lumps weighing as much as 10 lb. have been found.

Continuing down the slope of the hill the deposit merges into the main body previously described, but which, so far from being cemented, is of an unusually free and friable nature.

On the opposite side of the valley in the foot-hills of the main range is found the No. 1 lode, on which preliminary work has been done. The strike of the lode is east-west, and as far as it has been followed it is vertical. It can be traced for a distance of 2¼ miles and over that distance has an average width of about 3 ft. Following the outcrop, cassiterite can be seen throughout, and at the western end wolfram is associated with it. A prospecting shaft has been sunk on the lode to a depth of 110 ft., and drifts east and west extend for 60 ft. on each side of it.

The main features exposed by this exploratory work are the existence of a fissure with a filling material of quartz and an impregnated zone of country on each side of it. In places vugs of considerable size are found to be encrusted with large crystals of quartz, cassiterite, and zinc blende, the latter in the rare form of cubes. From surface to about 20 ft., oxidation has taken place, but below this the lode matter becomes complex, and at the bottom of the shaft over a width of 3 ft. 6 in. the lode consists of almost solid zinc blende. Although little visible cassiterite can be detected, it is nevertheless present and intimately associated with the blende. Carefully selected specimens of the latter mineral assayed 3½% metallic tin, notwithstanding that minute scrutiny failed to reveal any trace of cassiterite to the naked eye.

An analysis of a sample taken from the lode gave the following result:

	Per cent.		Per cent.
Zn S	12·21	Wolfram	0·140
Fe_2O_3	4·439	Silica	78·745
SnO_2	3·755		

A sample of partly concentrated ore analysed as under:

	Per cent.		Per cent.
Zinc	35·88	Tin oxide	15·73
Iron oxide	6·81	Sulphur	20·73
Tungstic acid	1·09	Silica	18·31

Other lodes have been discovered in different parts of the country, but no data are available to enable an opinion to be expressed as to the part they will play in the future development of the industry.

OCCURRENCES IN GREISEN. — Occurrences of cassiterite in greisen appear to be confined to the southern portion of the field. They are of no great extent, and possess the characteristics common to deposits of this nature. The only deposit of this class personally examined by me occurred on the side of a hill and appeared to be isolated and of limited area. The cassiterite is coarse, often crystalline, and of exceptional purity. Associated with the cassiterite are porphyritic crystals of hornblende, while the general features are similar to those of like occurrences in other parts of the world.

GRAPHITE IN MADAGASCAR

By JOHN W. SHELLEY.

Madagascar has rapidly come to the front as a producer of graphite. The author describes the deposits and the methods of mining and dressing. He gives also an outline of labour conditions, and of the mining laws.

LYING in a general north and south direction to the east of the centre of the island, there is a belt of Archæan rocks constituting what is termed the central plateau, having a mean elevation of about 4000 ft. It might be more correctly described as a ridge, as it is too rugged and undulating to possess any semblance to a plateau. Schists and gneisses enter largely into the composition of this formation, and it is in such that the graphite occurs disseminated in flakes or lenticles or compact in veins, pockets, masses, or beds, one form succeeding the other without any regular order, but generally without the continuity being broken. The stratification, if such it may be called, is most irregular, being twisted, contorted, folded, and faulted in all directions, adding considerably to the mining difficulties. These deposits lie at all angles of inclination, but, in many instances, seams and masses of considerable extent, and several feet in thickness, are found lying almost horizontal. The number of deposits is quite remarkable, and they contain practically an inexhaustible supply of ore. They extend from the north of Tananarive to the south of Fianarantsoa, a distance of about 400 miles. So far only the outcrops or superficial deposits have been opened up, but it is reasonable to infer that deposits exist also in depth. Work has been confined to these surface deposits for the usual economic reasons, and in a degree which permitted the work to be performed more or less profitably under the varying conditions prevailing. The deposits occur in rock which is decomposed to a great depth by atmospheric and chemical influences, which have converted them to the consistence of clay, rendering the extraction and subsequent treatment easy.

In some instances all overburden has been removed by denudation, permitting the mine to be worked by open-cut in the manner of a quarry by benches, or, preferably should I say as a clay-pit, as no blasting is required. Partly decomposed gneiss is generally interfoliated with the graphite, often forming also the parting between the seams. In most instances, however, soft micaceous or chloritic schists form the overburden and the partings. Garnet, tourmaline, corundum, magnetite, laterite, mica, quartz, and felspar are the associated minerals. The bulk of the graphite is in the form of thin flakes from $\frac{1}{8}$ inch diameter down to the finest dust, the amorphous variety being rare. Some very pure lumps, chips, and fibrous aggregations are found at intervals, but seldom in any quantity to render their separate treatment profitable. Doubtless in depth, below the zone of decomposition, more of such, with a less mixture of dust, will be found. As dug out and taken to the dressing-floors the ore contains 60% of graphite. Of this only about one-third is recovered by present methods of dressing. Of this, 60% of a tenour of from 90% to 96% in carbon, is suitable for the manufacture of crucibles and furnace linings, the remainder being fine dust used for various other purposes to which I shall refer later. Some deposits contain too large a mixture of iron and mica, the elimination of which is most difficult, owing to the iron oxide cementing the flakes of graphite together and to the fact that the scales of mica have almost the same specific gravity as the graphite. At present such deposits lie undeveloped awaiting the invention of some simple and cheap method of treatment. Several attempts have already been made in this direction and with success to some extent, but only at the expense of increasing the cost of treatment, already too high, beyond profitable limits.

COMMUNICATIONS. — The eastern escarpment, bordering the central ridge, along which most of the producing mines are found, is one unbroken succession of hills and valleys, to avoid which considerable detours have sometimes to be made, rendering road making and railway building difficult and expensive. Notwithstanding this the Colonial Government has made remarkable progress in improving the means of communication, forming an agreeable contrast to the only method of travel in vogue a few years ago when all transport was performed by human carriers along narrow and precipitous tracks, across swamps, and over mountains. There is now a line of railway open from the port of Tamatave to Tananarive, the capital, which is being prolonged to

Antsirabe, with extensions projected to Ambositra and Fianarantsoa. A regular service of government automobiles runs also twice a week in both directions between Tananarive and Mananjary passing through Ambatolamy, Antsirabe, Ambositra, Ambahamahasoa, and Fianarantsoa.

A region whence a large proportion of the graphite is obtained is the district of Vatomandry; this is largely due to the facilities afforded by the proximity of the port of Vatomandry, which helps to reduce the cost of transport.

PROSPECTING AND MINING.—The surface being invariably composed of decomposed rock, a Banka or Empire drill will be found most suitable for prospecting. The holes should be 100 yards apart and not more than 60 ft. in depth, as below that it would hardly pay to work. For proving ground, trial pits 50 ft. apart should be sunk, and a record in profile made of the strata traversed. Cuttings across the length and breadth of the depth of the deposit it may be proposed to work should also be made. These could serve as tramming exits in subsequent operations. Too great stress cannot be laid upon avoiding the damage done to a mine by the promiscuous digging-out of pockets.

The deposits being so numerous it is easy to make a choice of those most favourably placed for easy and economical working, while others meanwhile remain neglected. It is thus that deposits on the flank or summit of a hill which admit of easy drainage and disposal of the debris, or those which have the least overburden or sterile material to be removed, are usually selected. The deposits are usually worked by open-cut, except in a few instances where they are opened up by drifts into the side of the hill. Blasting or deep sinking is rarely done. After the removal of the overburden and intervening partings, the crude graphite, which is of a soft and friable character, is dug out by spades and removed in barrows and baskets to the sluices, which are situated at a lower horizon close to the mine. The sluices are scattered according to the whim of the tributor, who requires a site whence water may be easily led from the main ditch as well as a space for drying the product and for the disposal of the debris.

DRESSING.—As the chief commercial merit of flake graphite lies in its quality to resist strains and fusion when manufactured into crucibles and furnace-linings and subjected to high temperatures, the object to be aimed at in dressing is the production of large flexible flakes of a high tenour in carbon free from mica and iron. Elasticity is necessary to allow for expansion and contraction in heating and cooling, size gives the necessary cohesion, while purity is necessary to resist fusion. The present method of dressing is as follows: As it is dug from the mine, the ore is brought to the washing boxes, or so-called sluices, which

are rectangular wooden boxes 36 in. square by 24 in. deep, inside dimensions. They are let into the ground on three sides, and on the lower or fourth side there is a sliding door which can be raised to permit of the discharge of the debris into a trench dug for carrying it and the overflow water away. The boxes are filled to a depth of 8 in., the material to be washed being kept at that level by the addition of more material as it becomes reduced in the washing process. A steady stream of water equal to about 8 gallons per minute is led into the box on the upper side, while the material is being constantly and gently stirred by a labourer with a wooden paddle, the blade of which is 12 in. long by 6 in. wide. In this way the fine sand, mud, and flake graphite are kept in suspension and with the water flow over the lip of the box, into a small trough 6 in. wide by 2 in. deep by 12 in. long, having a piece of screen with 3600 holes (60 by 60) to the square inch nailed to the bottom. This trough is placed level, and the muddy water and fine sand pass through the screen, while the flake graphite is retained. The latter is automatically pushed forward, as it accumulates, by the gentle waves produced by the action of the paddle, and is discharged into a box 1 ft. square by 1 ft. deep placed to receive it. The washing process is completed in two operations, the first performed somewhat rapidly and with slightly more water in order to separate the bulk of the coarse material, and the second with a view to separate the particles of fine quartz and felspar, and to obtain a clear product. In this way each tributing gang produces about 1 cwt. per day. The debris, which is discharged at suitable intervals from the bottom of the boxes, contains a quantity of large flakes and chips, and some simple means has yet to be devised for recovering these without subjecting them to pulverization which would diminish its value. The washed graphite recovered is laid out on mats in the open to dry. This drying takes some time owing to capillary action causing the adherence of moisture to the flakes, the squeezing out of which is not to be recommended owing to its tendency to pulverize the material.

The next processes are those of vanning and sifting, and are performed by women. The former consists in tossing up the material so as to bring the dust and sand to the outside edge of an oblong wooden tray used for the purpose, and tipping it over the side by a dexterous movement of the wrists. It is afterward screened into the respective grades, which is a very simple operation. In this, 3 sieves 20 in. long by 14 in. wide, with woven brass of 20, 40, and 60 mesh respectively, are used. After being screened, it is taken to the central store where it is carefully tested by a staff of native samplers. If found satisfactory it is weighed and credited to the tributor at the rate of 10 centimes per kilo, equal to about £4 per metric ton. Rejected material, which is not up to standard, is returned to undergo further treatment. To see that they are credited with the correct amount, the tributors appoint one of their number to check the returns. As the tributors are paid according to weight they are sometimes tempted not to push the sifting to its proper limit. Much therefore depends on careful testing and requires constant attention.

It will be seen that the system described is both wasteful and expensive, and will easily lend itself to considerable improvement, particularly in the arrangement of the floors and economical distribution of the water, some of which might be used over again after being allowed to settle, as well as in the substitution of mechanical for the costly manual methods. But it is essential not to attempt a solution before giving all the factors careful consideration, as the present system has much to recommend it. Its installation is simple and cheap, local material being used entirely in its construction, while labour is plentiful and cheap. Mechanical appliances would demand a larger capital outlay, and to justify its use it would be necessary to aim at a large output over which it could be spread.

WORKING COSTS.—It is very difficult to get at the actual cost per ton produced under the present system in all cases as they are governed by varying conditions on different properties; but taking a typical instance of a mine with which I am acquainted that has been yielding an average of 25 tons per month for some time past at a profit, I am able to give the following figures:

	Francs per ton
Tributors, 10c. per kilogramme	100
Chief Recruiter's Commission	20
Assistant " "	10
Mechanics, Clerks, Samplers	20
European staff	75
Equal to £9	225

COST OF TRANSPORT.—This varies according to the situation of the mine and its distance from a wagon road or railhead. Most of the producing mines lie within reach of the main central road or the railway line or are linked thereto by serviceable roads. In some cases transport from the mine to the nearest road can only be effected by the aid of human carriers. The ports of exit are Tamatave and Mananjary, both on the east coast. Generally the mines south of Ambositra export via Mananjary, while those to the north export via Tamatave. The costs in both cases are approximately as follows:

Via Mananjary

	Francs per ton
Bagging	20
Cartage from mine to main road	7·50
" to Mananjary	70
	97·50

Via Tamatave

Bagging	20
Cartage from mine to main road	7·50
„ to Tananarive	55·00
Rail to Tamatave	48·00
	130·50

A proportionate reduction must be allowed as the mine approaches the port.

Freight and shipping charges through to London via Marseilles or Havre during normal times are as follows:

Via Tamatave

	Francs per ton
Shipping	5·50
Statistic 10 c per bag	1
Insurance	3
Freight	62
	71·50

Via Mananjary

Shipping	8·50
Statistic 10 c. per bag	1
Insurance	4
Freight	78·50
	92·00

Good shipping facilities exist at Tamatave, while at Mananjary, which is only an open and exposed roadstead, the facilities are uncertain and the frequent cause of delay and loss. Doubtless this will be soon remedied, as the present trade of the port seems to warrant it.

OTHER COSTS.—The preceding schedules do not include incidental expenses such as for stores, travelling, office, telegrams, stationery, postage, sundry transport, and taxes, which must also be taken into consideration, and may be roughly set down at another 30 francs per ton, bringing the total cost up to between £17 and £19 per ton c.i.f. London. Taxes figure for about 14 francs per ton as follows: Tax on output at the rate of 2½% ad valorem at mine, equal to 5 francs on 200 francs; Concession tax at the rate of 2 francs per hectare per annum on 500 hectares, say 9 francs per ton.

PRODUCTION.—The world's production of graphite, of all descriptions, is estimated to have amounted to 120,000 tons in 1913. Of this quantity Ceylon produced one-third, or 40,000 tons, and Madagascar 8000 tons.

The following table gives the exports of graphite from Madagascar:

Year	Tons
1909	19
1910	545
1911	1,247
1912	2,732
1913	6,572
1914	7,939
1915	estimated 12,000

The average declared value of the exports in 1913 was 450 francs per 1000 kilogrammes (£18). In 1914 it fell to 400 francs (£16). In 1915 the average price is expected to reach 500 francs (£20).

The Madagascar production was exported to Europe, and consisted principally of flake graphite for the manufacture of crucibles and furnace linings, with a lesser quantity of fine dust for various purposes.

The following are the proportions:

	%
Crucible retorts	60
Furnace and converter linings	15
Paints	10
Lubricants	10
For foundry mouldings	5

The market is governed by the supply and the demand, and as they fluctuate within wide limits it is impossible to give any prices to form a reliable basis for calculations. Whether the demand will continue to increase it is impossible to say, but it is quite probable that it will, to keep pace with industrial progress in which it forms an important element. There are such vast resources available in Madagascar that, even if the production in other parts of the world were to fail, they would be quite equal to any demand made upon them. At present the demand for fine dust is limited, and as it is produced in excess, forming a sort of by-product, there is a supply of it in reserve awaiting a profitable outlet.

LABOUR.—There is a sufficient native population upon which to draw. The Malagasy are essentially agriculturists and pastoralists, in which pursuits they display considerable skill and energy. Some of their irrigation works are veritable monuments of skill and industry. After supplying their own food requirements, they provide little beyond what will suffice to pay their taxes and buy a few luxuries. They are almost self-supporting, that is to say, they manufacture almost all their requirements in the way of clothes and articles of domestic and agricultural use. Their habits are frugal and abstemious and, altogether, they are a happy and contented people, and dire want is unknown to them. Their average income in money value probably does not exceed twopence per day, and if a European were to employ them to cultivate rice, which is their staple product, after their own manner but paying them at the same rate as is paid for their labour at the mines, it would cost him considerably more than a halfpenny per pound, which is the price at which it can be purchased almost everywhere. Nevertheless they are not easily tempted by the offer of higher wages to work for others, and when after much difficulty a force is recruited, it is almost impossible to induce them to stay on through the planting and harvesting seasons, November and December, and March and April. Such labourers, therefore, as can be got must be handled with tact, and are best controlled by a European who understands their customs and speaks their language, assisted by suitable native overseers. They are conservative and generally prefer piecework, where they are free to employ the methods to which they have been accustomed. Otherwise they are fairly industrious, intelligent, obedient, and peaceful. There is an industrial and educated class which can be drawn upon for clerks and useful artisans and mechanics skilled in various trades. To ensure and retain a good supply of labour the camp should be made as attractive as possible, and where it is situated far from a village some comfortable dwellings with plots of ground adjoining should be provided, as well as a school for the children and a place of worship. This can be undertaken gradually, and before embarking upon a considerable outlay in that direction it would be better to wait until the mine had been opened sufficiently to ensure a supply of ore for several years. It is particularly necessary to provide good camps in the cold misty altitudes or in the forest belt. All natives provide their own food, so that there is seldom any difficulty under that head.

The rates of pay are as follows:

	Per day s.	d.
Unskilled labourers	0	6
Skilled ,,	0	7½
Rough carpenters	1	8
Cabinet makers	2	6
Blacksmiths	1	8
Strikers	0	10
Fitters	1	8
Lumbermen and sawyers	0	7½
Bricklayers	1	8
Brickmakers	0	10
Personal carriers (Filanzana Bourjanes)	0	10

	Per month £	s.	d.
Cook	0	17	0
Houseboys	0	8	6
Overseers	0	17	0
Headman	3	10	0
Interpreter	3	10	0
Clerks, storemen, samplers	1	0	0
Messenger	0	12	6
Watchman	0	12	6

FUEL.—No mineral combustible accessible to the mines in this region is known to exist. Forests covering a considerable area abound everywhere capable of furnishing a certain amount of fuel and an unlimited supply of timber for all building and mining requirements.

WATER.—The region under review enjoys an abundant rainfall, the wet season lasting 5 to 6 months from November onward. The schists and fissured granites act as reservoirs, and the water is retained to be gradually released to feed the perennial flowing streams. There is consequently a supply sufficient for all purposes almost everywhere throughout the year. Waterfalls of great power and beauty are numerous, and are available as a source of energy.

CLIMATE.—The climate of this central region cannot be surpassed. It is sub-tropical and rarely oppressively warm or excessively cold. Snow and ice are unknown, but the nights are deliciously cool and blankets are always necessary. At high elevations a fire is sometimes needed after sundown. The range of temperature is between 45° and 70° F. in the dry season, and between 55° and 90° F. during the wet season. In the mountains it is invariably cold and misty. The numerous rice lands and forest belts exhale fever-propagating miasma at certain seasons, but with moderate care Europeans do not contract malaria. Europeans can follow their avocations here without suffering any discomfort due to climate, but they are never called upon to exert themselves, it being customary for the natives to perform all manual tasks.

FOOD is both abundant and extremely cheap. Almost every description of cereal, vegetable, and fruit common to Europe as well as those common to the Tropics are obtainable in season. Beef, mutton, pork, poultry, eggs, butter, milk, cheese, and honey are always obtainable.

LIVING expenses are very moderate. Good brick dwellings can be had in the towns at low rents. Well made furniture is obtainable locally, and there are stores where almost any imported article may be purchased. Good schools for the education of children under the management of Jesuit and Protestant missions exist in all important centres. There are hotels, post and telegraph offices in all important towns. In a word, unless compelled to depart from the beaten track, all the comforts and necessaries of civilization are within reach. Although I have confined my observations to this region, I would state, lest it be assumed that the whole of Madagascar enjoys the same advantages, that the coast belts are not so pleasant to live in, though for the planter raising coffee, sugar, rubber, or tobacco on the eastern slopes, or for the cattle rancher on the western ranges, the climate and conditions have no terrors.

MINING LAWS.—The mining laws are liberal, and afford every inducement and security for the investment of capital. The officials who administer them are well disposed toward Britishers, and are uniformly courteous and obliging. The mining regulations are simple and easily understood. Separate and distinct regulations apply to precious stone and metal mines. Outside these the mines are divided into 4 classes as follows:

1. Mineral fuels, petroleum, bitumen, and asphalte.
2. Rock-salt and its associates.
3. Phosphates.
4. All other mineral substances.

Graphite falls under the last class. Quarries, chalk and clay pits, gravel pits, and peat bogs do not come within the definition of mines.

All minerals in the same class may be worked under a permit for that class, but different individuals may hold separate permits for the same ground for different classes of mineral. Holders of permits for precious metals take priority for wood and water. It is seldom, however, that the two interests clash. Prospecting permits do not secure surface rights, except where ground required for mining operations is not already occupied or under cultivation, when it may be reserved with the consent of the mining commissioner. If cultivated or occupied land and water rights are taken, the tenant must be compensated, but this presents no great difficulty as land is cheap. There is also so much vacant land available that it is seldom necessary to take what is already occupied. Forest and water rights are vested in the Government, and permission to use them, whether within or without the boundaries of the claim, must be obtained from the Chief of the Service of Public Domains.

Prospecting licences for one year, renewable for another year, are issued to Europeans domiciled in the Colony upon payment of 25 francs per year. These confer exclusive prospecting rights under the class applied for over an area not exceeding 2500 hectares ($9\frac{3}{5}$ square miles) which is not already staked. Plans of the district are always obtainable, so that it is easy to see what ground has already been pegged. A company can only hold similar rights if it is registered in France or in the Colony and constituted according to French law. The claim may be worked and the product sold during the term of the prospecting permit. This is permitted, though the Mines Department gives warning that it may be stopped without further notice. A claim should be suitably beaconed, and a rough plan should accompany the demand for a permit. A full survey at this time is not necessary. A tax of $2\frac{1}{2}$% ad valorem on the output sold becomes payable. No mineral is allowed to be sent away without being accompanied by a permit, and a proper record of all consignments must be kept in a special register. Claims can be sold and transferred, but the Department does not recognize mortgages. Should the Department refuse to renew a permit, the difficulty may be surmounted by demanding a new permit at the exact moment the old one expires, or by instructing a third party to apply for a permit in his own name on your behalf. These evasions are tacitly permitted at present, but I believe some new regulations referring thereto are under consideration, as the Government is opposed to ground being held up for purely speculative purposes, and desires to see owners work their properties, or at least make some serious attempt to do so during the term of their occupation.

Meanwhile in the case of a proved mine of value it is much better to secure a valid and incontestable title by asking to have the claim, or such portion of it as may be necessary, converted into a Concession. It is at this moment that any real opposition which may have been simmering becomes active, as always happens in similar cases, and it is therefore a good plan not to let outsiders know your projects. As prospectors' boundaries, where no survey has been made, are often imaginary and generally very elastic, it is when the ground comes to be surveyed that your neighbours suddenly discover your wish to take in some of the wealth they dreamed lay waiting for them. The absolute fairness and impartiality of the officials of the Mine Department, with whom the decision rests, can be trusted, and unless he can prove a very good case the opponent is ignored.

The whole area of the claim originally pegged may be applied for as a Concession, but as the taxes become somewhat onerous in proportion as the area increases, it is better to select only such portion as has been previously proved or which will probably prove remunerative to work.

The Concession taxes are as follows:

1	franc	per hectare	per year	up to 200 hectares
2	,,	,,	,,	,, 500 ,,
3	,,	,,	for all above	500 to 1000 hectares
4	,,	,,	,,	1000 to 1500 ,,
5	,,	,,	,,	1500 to 2500 ,,

This tax only becomes payable after the expiration of the second year from the date the Concession is granted. A survey by a sworn surveyor must be made of the ground, and a plan thereof lodged with the Mines Department at Tananarive. Notice of the application must be inserted three times in the *Journal Officiel* at intervals of a month. All agreements and contracts should be drafted by a qualified attorney, and to become valid they must have the signatures thereto attested by the resident magistrate of the district.

CONCLUSIONS. — Two important conclusions can be drawn from what I have described above. Firstly that there is an abundance of high-grade and easily mined graphite ore in Madagascar, and secondly that the present cost of its treatment is quite out of proportion to the merit of the proposition, leaving room for considerable improvement. As I have shown that there is a market for all that can be produced, and as 8000 tons produced in 1913, at an estimated average cost of £9 per ton at the mine, were presumbly sold at a profit, it follows that any reduction in the cost of production must be clear gain. With such a wide margin it ought to be possible to effect a considerable reduction, and the problem is how can it be best achieved. Labour-saving appliances are clearly indicated. With the same staff at present taken to produce 25 tons of marketable graphite, it should be possible by the aid of such appliances to produce 250 tons with a corresponding decrease in costs and an increase in profits. This is the kind of problem engineers enjoy tackling, and I gladly place it before them, and can promise a rich reward to the first who succeeds in solving it. The whole difficulty lies in the question how to expeditiously and cheaply separate the graphite from the sterile matter. Experiment has already proved that the known hydraulic methods are unsuitable, but it may yet be found, on further investigation, that one of these may be modified so as to meet the case. As some guide I give the average specific gravities of the materials to be separated: Biotite mica 2·90, muscovite mica 2·75, quartz 2·65, felspar 2·60, chlorite 2·60, graphite 2·20.

As the object is to obtain a perfectly clean product the difficulties are increased by the fine mud and iron oxide in suspension, much of which can be separated after drying by screening, but this only adds to the number of operations which it is sought to avoid. Also it must be borne in mind that graphite and mica being in thin plates or scales will not settle as rapidly as other matter of the same specific gravity having a granular structure. Some deposits are practically free from mica, and in such instances no special process is required for its separation.

Of the graphite in the ore it will sufficiently answer for present requirements if only the flakes which will not pass a 40-mesh screen are recovered in the first operation. The finer material which has a less value could be recovered by subsequent treatment if found desirable.

Should it be attempted to solve the problem by a dry process similar to winnowing or screening, it is important to bear in mind that its value is diminished if attrition subjects the graphite to pulverization. For this reason several attempts in this direction have failed.

British Output of Minerals during 1915.

The Home Office has issued a preliminary return of the mineral output of the United Kingdom during 1915. We give the figures herewith, together with those for 1914:

Description of Mineral	Total in 1914 Tons	Total in 1915 Tons
Antimony ore	—	2½
Arsenic	1,974	2,496
Arsenical pyrite	—	14
Barium (compounds)	45,910	60,801
Bauxite	8,286	11,723
Chalk	493	286
Chert, flint, etc.	3,844	3,033
Clay and shale, other than fireclay and oil shale	531,000	322,708
Coal	265,643,030	253,179,446
Copper ore and copper precipitate	2,519	746
Fireclay	2,374,068	1,839,746
Fluorspar	24,688	25,577
Gold ore	47	5,086
Gravel and sand	17,331	10,699
Gypsum	220,096	204,574
Igneous rocks	44,933	43,089
Iron ore	8,984,492	7,876,105
Iron pyrite	11,654	10,535
Lead ore	25,988	20,698
Lignite	300	1,783
Limestone	334,779	287,680
Manganese ore	3,437	4,640
Ochre, umber, etc.	4,463	4,030
Oil shale	3,268,666	2,998,652
Rock salt	189,995	131,348
Sandstone (including ganister)	211,916	199,046
Slate	82,307	48,893
Soapstone	180	750
Tin ore (dressed)	6,635	6,420
Tungsten ores	205	329
Uranium ore	344	82
Zinc ore	15,419	12,057

DISCUSSION

Caving Methods of Mining.

The Editor:

Sir—My letter on 'Caving Methods of Mining,' published in October 1915, has received caustic comments from Mr. W. J. Stanford in in your issue for March last.

This correspondent, while condemning the method of mining described briefly in my previous letter, and expressing surprise that such a system should still be in use, also says it would be interesting to hear from me again, and especially to know costs. Why a method which Mr. Stanford condemns unreservedly, and "is full of holes," should be of any further interest to him, perhaps he can explain. It is evident, however, from his remarks that he does not fully understand such a method of mining, nor the *modus operandi*. As the subject could not be fully handled within the compass of a letter, I can excuse his want of knowledge, especially as I know of no printed matter on the subject beyond the paper entitled 'The Extraction of Ore from Wide Veins or Masses' by Mr. G. D. Delprat, which is published in the Transactions of the American Institute of Mining Engineers, Vol. XXI., to which I would refer him.

It may interest Mr. Stanford to know that since the above mentioned article was written in 1893, the method of mining described therein has been put into practice in several important mines, under the direction of some well known mining engineers. And there is no doubt that had the method been understood, or perhaps I may say, known more generally, it would have been more widely adopted, for there are numerous instances, within my knowledge, where its application would have resulted to the advantage of all concerned, especially to shareholders.

The application of the method to Mr. Stanford's hypothetical orebody, 90 ft. long by 15 ft. wide, would, in my opinion, not be advisable or necessary, but when it comes to dealing with orebodies 500 to 2000 ft. in length and 100 to 300 ft. in width, such as are found in the cupriferous pyrite mines of Southern Spain, then, I fear, Mr. Stanford's method of mining would be found wanting.

Again, Mr. Stanford is quite at fault when he says: "The Cabezas del Pasto system also must abandon for ever the whole area of the stope under-foot, say in No. 1 level. This cannot be mined on rising from No. 2 level without bringing down the whole of the filling above." As a matter of fact there is no difficulty in stoping out the floor of the level above right up to the filling resting on the floor. To quote Mr. Delprat: "it is found that the stowing (filling) gets so tightly packed as to be quite firm, and with a little additional care it is comparatively easy to mine below it." He further says that during eight years while the system was in operation at Cabezas del Pasto, only one man was killed by falls of roof.

Strictly speaking, this method of mining cannot be termed a caving method at all, as neither the roof of the stope nor the ore is caved, nor is there any appreciable subsidence of the surface of the ground. As the ore is removed, its place is filled or packed with waste rock, sent down from the surface, and of course it means that every stone has to be handled. But there is no getting "the waste rock up to stope after stope" as Mr. Stanford assumes. Each level is supplied with stone from the floor above, trammed to the place required to be filled, and not raised from stope to stope. As against the more apparent than the real objection to stowing and filling stopes with waste rock, under this system, the ore mined is undercut and has two free faces, so that a miner will break about 3 tons per shift, instead of about $\frac{3}{4}$ ton when working under the pillar and stall system, or on a solid face of ore.

As regards costs, the following figures are taken from Mr. Delprat's paper:

Mining Costs, Excluding General Expenses.

	Dollars per metric ton.	
Labour	0·521	
Materials	0·132	
Tools	0·0091	
Workshops	0·024	
Depreciation—Machinery	0·0273	
Do. Wagons and rails	0·0035	
		0·717
Quarrying stone, filling and stowing		0·149
Total		$0·866

Wages.

Mine foreman	$1·00	per shift
Miners	0·52 to 0·70	,,
Trammers	0·52	,,
Labourers	0·43	,,

The cost of labour in the south of Spain is given in United States currency. A comparative estimate of the cost of mining under this method might therefore be made, on the base price of labour in any other country, taking into account the rise in wages and cost of materials at the present time.

A. G. WHITE.

London, May 8.

A Cornish Mining Board.

The Editor:

Sir—I am entirely in accord with the proposal to constitute a Cornish Chamber of Mines for the express purpose of promoting the best interests of the Cornish mining industry, and of linking up its operations with the interests of the British Empire.

When the late Mr. J. H. Collins asked me to help him in the formation of the London and West Country Chamber of Mines, I heartily supported the movement, became a member of the Council, and subscribed to it until the movement was abandoned.

I believe it failed because it did not get into sufficiently close practical touch with the commercial elements it was intended to foster. There are many very serious problems ahead of the Cornish tin mining industry. There has been a great awakening due to the flood of light which the war has let into international relations, and the effect of industrial competition thereupon, particularly in the mineral and metal industries.

Our great industries have been built up by the unsupported efforts of the great captains of industry. I believe in every branch of industry we have the greatest leaders in the world; but as individualists their day has gone, and we now know that organization of the national resources, supported by wise legislation, is the only possible method of stemming the stressful industrial competition which we may expect to develop still more acutely after the war. The national importance of the mineral and metal industries and of the necessity for their protection from alien control needs no argument today.

The proposed Cornish Chamber of Mines is a method of organizing one branch of the industry, and in my opinion there can be no question whatever as to the great good that is bound to result from its operation, if the members will only be true to the Cornish motto 'One and All,' and all work together for the good of the industry without any personal aims or motives.

The technical work should be the first care of technical institutions. These we have already; but the commercial and industrial functions must be the joint care of representatives of every phase of the industry.

Probably the two greatest Chambers of Mines the world has ever known are those at Johannesburg and Kalgoorlie, though very few people except those who have been members of them have even a faint conception of the immense work which has been quietly done by them. In those institutions the subscriptions and the nomination of representatives on the council are on a *pro rata* basis. Thus, the largest mine pays the largest fee, and nominates *pro rata* its proportion to the council.

Mr. Herbert Thomas, in his excellent letter, has pointed out some of the pitfalls, and there are others on which I need not enlarge. He refers to the difficulty of selecting a president. May I point out that Mr. Richard Hamilton, general manager of the Great Boulder mine, has just been re-elected for the 19th year in succession to the presidency of the famous Kalgoorlie Chamber of Mines.

W. H. TREWARTHA-JAMES.

London, June 2.

Glass-Top Concentrating Tables.

The Editor:

Sir—In your May issue you publish a letter from Mr. R. T. Hancock criticizing the results of a test made by East Pool & Agar Ltd. on the glass concentrating table as described in your issue of January last.

The figures obtained by the use of well known formulæ are interesting, but, having assisted in making the test, and being responsible for all the assay results, I venture to make a few remarks which may serve to elucidate a few doubtful points.

Mr. Hancock suggests that the automatic sampler was used to determine the quantity of feed flowing on to the tables. This was not so. A regular independent flow-sample of the whole feed was taken every hour, and the average figure was used as a basis in calculating the tonnage of pulp treated on the two tables during the 16 hours test, the amount being, in the case of the glass frame, 3·755 tons, and the wood frame 2·540 tons. The weights of the tailing were taken as being equal to the difference between the weight of the feed and the weight of the concentrate.

You will see from this that the figures given in the second table on page 32, as the extraction of metal, are not theoretically obtained by the use of a formula, but are actually the amount of tin extracted, stated as a percentage of the feed. Looking at it from a practical point of view this is infinitely more important than a theoretical extraction, when considering the matter of £. *s*. *d*.

Regarding the identity of the two tailing samples, these are quite correct. The difference in the extraction of the two tables is accounted for by the fact that the glass frame only recovered 10% of the weight of the feed in its concentrate, whereas the wood frame recovered 27·3%; and although the value of the glass concentrate was higher than that of the wood, still it was not sufficiently high to make the actual pound of tin recovered by the glass frame from 1 ton of ore equal to the amount of tin recovered by the wood frame from the same quantity of feed.

At first sight the fact of the two tailings being equal in value might be misleading, but, when reasoned out, it will be seen that the assay-value of the tailing does not enter into the calculation of the actual extraction, this being governed solely by the amount of tin in the pulp fed on to the table and the amount of tin recovered in the concentrate, which in the case of the glass frame was 12·17 lb. Sn and 34·54 lb. Sn respectively, giving an extraction of 35·23%. In the case of the wood frame the figures would be 23·4 lb. Sn and 10·4 lb. Sn, giving an extraction of 44·44%. I may add here that the figure 34·7%, given in the article as the extraction on the glass frame, was an error in transcribing the weight of feed of the glass frame, and should have read 35·23%.

J. WARING PARTINGTON,
Chemist, East Pool & Agar Ltd.
Carn Brea, May 23.

The Editor:

Sir—In the May issue of the Magazine, Mr. R. T. Hancock has contributed a thoughtful and instructive analysis of East Pool results which I read with great interest. It does not follow, however, that the work of the automatic sampler was defective, or that its deficiencies account for the differences to which he rightly calls attention. I think he has overlooked the inevitable differences which occur in the determination of the metallic content of tin samples: in other words, the assaying differences, which may well be as great, or even greater than the sampling differences.

In the case of the comparative figures referring to the test on glass surfaces, the agreement is so remarkably close that it might be held to confirm both the work of the automatic sampler and of the assayer. In all probability this close agreement is the result of compensating errors. For instance, the samples may have been a little high, the assaying a little low, to about an equal extent. If there were no differences at all the coincidence would be extremely suspicious.

In the case of the tests on wood surfaces, the difference is more marked, but it is less than 0·5 lb. of metallic tin in the tailing assay, which is by no means an unusual difference in assaying low-grade tailing for tin, unless exceptional precautions are taken. In fact I read the same figures as fairly confirming the opinion I personally formed as to the accuracy and suitability of this sampler for the particular conditions under which it was operated, on the assumption that you can fairly divide the difference between the assayer and the sampler.

W. H. TREWARTHA-JAMES.
London, June 2.

Glass Top Tables at Tincroft.—In our last issue we published a letter by Mr. W. Morley Martin containing a table of results of competitive tests of glass and wood surfaces at Tincroft, these figures having been supplied by the manager, Mr. William Thomas. As there have been so many errors in connection with the details of tests of the glass table, one of our friends considered it advisable to check Mr. Thomas's figures for percentage of recovery, using the formula quoted by Mr. Hancock in a letter on the same subject also published in the May issue. The result of this investigation is to prove that Mr. Thomas's figures are all wrong, and that they have been calculated on an entirely erroneous basis. He seems to have calculated the percentage of loss by dividing the assay-value of the feed into that of the tailing.

We have accordingly recalculated the percentages of recovery on the correct basis, and we give the real figures, side by side with Mr. Thomas's figures.

Wood Surfaces		Glass Surfaces	
As Printed	Properly Calculated	As Printed	Properly Calculated
62·59	79·31	75·00	80·77
62·59	77·22	75·00	79·66
61·54	77·96	74·28	80·01
71·30	85·89	77·80	86·44
60·00	69·60	65·00	73·90

It will be seen that the real figures are not so favourable to the glass surface as were those given by Mr. Thomas, so that Mr. Morley Martin's argument is necessarily weakened.

SPECIAL CORRESPONDENCE

JOHANNESBURG.

THE FAR EAST RAND.—The appearance of another report by Mr. R. N. Kotze, the Government Mining Engineer, on the Far East Rand, constitutes the principal event of the month, although it cannot be said in its leading features to differ materially from the evidence the same authority gave before the Dominions Royal Commission.

The total area of the Far East Rand is estimated at 247 square miles, or 107,440 claims, of which 203 square miles or 88,191 claims contain the Main Reef Series at a vertical depth of less than 5000 ft. Mr. Kotze mentions that, judging from the information at present available, it is doubtful whether the reef at depths exceeding 5000 ft. will prove to be payable, but nevertheless it has been included in the scope of the discussion. According to Mr. Kotze, this area contains 16,467 claims that will probably be available for leasing. No details are given by Mr. Kotze explaining why a vertical depth limit of 5000 ft. is set up, but it would appear that this limit is based on the reef becoming unpayable by reason of the falling away of the grade with depth, so that like many others Mr. Kotze has adopted the view that the Main Reef does undoubtedly decline in value with depth.

Mr. Kotze's report was prepared for the Commission appointed by the Government to inquire into the possibilities of the Far East Rand, and to suggest some equitable way in which the leases for working the gold areas can be arranged, and naturally therefore it is with the area available for leasing that the report principally deals. The amount of capital required has been the subject of discussion in the Union Parliament, where the Minister of Mines stated that it was estimated at fifty millions sterling. At the time this figure was criticized as being too small. Mr. Kotze again estimates this to be the amount of capital required, but it now appears that only the working of the area available for leasing carrying the reef at less than 5000 ft. has been taken into consideration, no regard having been paid to owners' claims, proclaimed diggings, areas carrying Main Reef at depths over 5000 ft., or the large area held by existing companies, only about half of which is at present producing gold. It may be mentioned that while Mr. Kotze gives the total area of the Far East Rand goldfield at 107,440 claims, his estimate of fifty millions sterling for working capital is now based on what is required for an area of 49,200 claims, which may explain the cause of the difference of opinion existing on the question of capital requirements. The opinion generally prevails that the capital required to sink shafts, and develop and equip mines, will be in the neighbourhood of £1000 per claim.

Mr. Kotze gives the average dip of the unexplored area as seven degrees, and states that only one reef, the Main Reef Leader, is likely to be worked. For the purpose of estimating the probabilities in the explored areas, an average stoping width of $4\frac{3}{4}$ ft. is assumed. The percentage of unpayable areas varies from 15 to 80%. Mr. Kotze estimates that 60% of any area may be assumed as unpayable. The opinion here seems to be that a payable percentage of 40% of the whole area of the Far East Rand is optimistic.

Several attempts have been made recently by the Government to induce capitalists to tender for the working of the Government areas between Springs and Brakpan, but as the suggested conditions of lease were not sufficiently attractive no tenders were made. Mr. Kotze goes very fully into this aspect of the Far East Rand, and puts forward some excellent suggestions upon which to base the new legislation intended to deal with these new Government areas. With respect to the size of the areas required for lease, Mr. Kotze suggests that they should comprise such an area as will be capable of returning annually, over a period of 20 years, dividends of at least 15% on the actual working capital expended, plus a further annual sum which if invested at 3% will at the end of 20 years amount to the capital expended.

The working capital will be represented by the amount actually expended on shaft-sinking, equipment, and advance development plus an allowance of 6% per annum interest up to the date of starting of the mill, so that a dividend of 18% will be called for. Under this scheme no room will exist for promoters' or vendors' interest, which in the past has added considerably to the nominal capital of Rand companies, it having become increasingly evident of late that the ultra deep mines of the Rand cannot in future be expected to pay satisfactory dividends on such large nominal capitals. Another excellent suggestion of Mr. Kotze's is that the Government share of profits should be decided by a sliding scale based on actual profits. But there are so many different factors to be considered that the amended legislation should make provision for the appointment of a Mining Lease Board to settle all these knotty questions.

In conclusion Mr. Kotze points out the absolute necessity of the Far East Rand being opened up as quickly as possible, especially as according to the evidence placed before the Dominions Royal Commission two years ago, the number of producing mines on the Rand in eight years time will be reduced from 58 to 33. Only two new producing mines have been added to the list since the above estimate was made. Mr. Kotze further estimates that if only one-half of the claims in the Far East Rand not held by producing companies containing reef at a less depth than 5000 ft. prove remunerative on the conditions previously stated, the Far East Rand should yield gold to the approximate value of £450,000,000.

TORONTO.

PORCUPINE.—The remarkable expansion of the gold-mining industry of Northern Ontario is indicated by the annual reports of the leading companies. The report of the Dome Mines for the year ended March 31 shows a production of bullion to the value of $1,778,958, from the treatment of 347,640 tons of ore, the average yield per ton being $5·11. Net operating profits were $912,379, as compared with $315,179 for the previous year, being at the rate of 22·8% on capital stock. The net surplus for the year was $541,861 and the total surplus $1,202,560. Operating costs were reduced from $2·96 to $2·55 per ton. The ore reserves as at April 1 were estimated at 2,600,000 tons, valued at $16,120,000. The figures for April showed a production of $177,000 from the treatment of 37,300 tons of ore of the average value of $4·75 per ton, and a further reduction of costs to $2·41 per ton. The consolidation of the Dome Extension with the Dome has been duly ratified by the shareholders and the work of testing the Extension property has been begun.

The fifth annual report of the Hollinger shows that during the four years ended with 1915 the company has paid in dividends $4,170,000 and recovered gold worth $9,304,000 from 728,000 tons of ore. The estimated ore reserves have increased during that period from 462,000 tons valued at $10,230,000 to 1,600,800 tons valued at $16,031,600. During 1915 the tonnage milled was 334,750 tons, of the gross value of $3,384,666, an average of $10·11 per ton. Exclusive of taxes and depreciation a working profit of $6·16 per ton was made. Gross profits amounted to $2,063,466, an increase of $276,787 over the previous year, and net profits to $1,916,466 of which $351,466 was carried to surplus, the total surplus being $1,478,209.

A merger has been effected between the Hollinger, Acme, and Millerton mining companies and claim 13,147 of the Canadian Mining and Finance Co. under the title of the Hollinger Consolidated Mines Ltd., with a capital of $25,000,000 in $5 shares, which are allocated as follows :—200,000 to remain in the treasury, 2,400,000 issued to Hollinger shareholders, 2,100,000 to Acme shareholders, 200,000 to Millerton shareholders, and 100,000 to the Canadian Mining and Finance Co. This arrangement was recommended in an exhaustive report by the manager, P. A. Robbins, which sets forth that this step has been in contemplation for five years. The centralizing of the plant and the development of underground workings have been undertaken with the idea of an ultimate consolidation of the properties, and a point has been reached where a comparative valuation of the properties would furnish a basis for the merger. Mr. Robbins' report deals with the allowances for ore at depths below those already reached by development upon the two principal mines. On the basis of a depth of 800 ft. it is estimated that the Hollinger and the Acme will have 5,594,570 tons of ore of a gross value of $48,196,390. On the assumption that the veins persist to a depth of 1400 ft., as some of them are known to do, it is estimated that these two properties have 10,430,000 tons with a value of $81,492,000. Forecasting the result of mill extensions and improvements now in progress or in contemplation and the completion of the central shaft, the report estimates that the company, with the expenditure of $750,000, will be able to increase the capacity of the mill to 3500 tons daily, and probably to increase the dividend rate. The preliminary work for the extension of the mill has been started. The stamps will be retained and 100 more stamps installed. During the 4-weekly period ended April 21, the mill treated 42,673 tons of Hollinger and Acme ore of the average value of $9·09 per ton, realizing gross profits of $158,646.

COBALT.—The increase in the price of silver has resulted in renewed activity and interest in the Cobalt camp, and abandoned prospects and mines that had been closed as unprofitable are being re-opened. Labour is much in demand owing to so many miners having enlisted, and the majority of the companies have given their underground workers an increase of 25 cents per day, and in addition a bonus to all classes of 25 cents per day during every month in which the price of silver averages 70 cents per oz. The Nipissing during April mined ore of an estimated value of $167,446, and shipped bullion from Nipissing and custom ores of an estimated net value of $447,546. The La Rose statement for the quarter ended March 31 shows a balance of $940,738. R. B. Watson, general manager, has resigned, and is succeeded by G. C. Bateman, formerly connected with the Canadian Mining & Exploration Co. The McKinley-Darragh has struck high-grade ore in a rise on vein 20 from the 200 ft. level. The adoption of the flotation process has resulted in an increased extraction of silver, and has enabled the company to work mill tailing at a profit. The Crown Reserve has taken an option on the Cochrane mine adjoining the Timiskaming, and is unwatering it for a thorough examination.

A section of the Gillies Timber Limit adjoining the Cobalt area, comprising nearly 8000 acres, has been thrown open for prospecting and staking. Portions of the limit have been opened for mining operations at one time and another and some development undertaken, but so far without profitable results. The formation of the section now thrown open is solid conglomerate with few contacts, and the chances for important discoveries do not appear to be promising.

CAMBORNE.

LEVANT.—With cost-book companies, it is almost hopeless to make comparisons of costs from account to account, because materials are charged as purchased and not as used. Thus at Levant for the 16 weeks ended December 18, 1915, it cost in all £13,589 to handle 8647 tons of ore, while for the succeeding 16 weeks, to deal with 8379 tons cost in all £15,282. We wonder when this antiquated method will be superseded by an accurate cost system, which is essential as an aid to economical working. This criticism is, however, by the way. It is gratifying to note that, for the past four months, the accounts show a profit of £2003. The ore milled showed a recovery of 41 lb. of black tin per ton, as compared with 34 lb. for the previous four months; while, also, unstated quantities of arsenic and copper were recovered. This satisfactory improvement coincided with an £18 rise in the sale price of the tin concentrate, so that in spite of the increased working cost, the net result satisfied the shareholders, who decided to divide 10s. per share.

The meeting was pleasant for other reasons; it was announced that at last the lords had been persuaded to grant a new lease on terms that were acceptable to the largest shareholders. One of the bones of contention had been the claim of the shareholders that when the mine was being worked at a loss there should be no royalties payable; although not conceding this, the lessors have agreed to accept one-quarter dues in such a case. Another difficulty had been the demand of the lessors that £60,000 should be spent on a submarine shaft. It has now been decided that after the first five years of the term of the new lease, should the mine be sub-leased, one-half of any profit earned shall be expended on either sinking a new vertical shaft from the surface of the inland mine to the 278 fathom level, or on converting the existing skip shift into a vertical one. For the first five years of the new lease, a sum of not less than £5000 has to be spent on development at or below the 350 fathom level. This drift west is the best prospect in the mine, and now that a new lease has been secured, the development will doubtless be vigorously pushed.

IMPROVED PROSPECTS.—The recent improvements in the assay-values at both Basset and Dolcoath have directed attention to the possibilities of these mines and, as a consequence, there has been some local buying of the shares. Basset made a loss of £3024 in 1915, the recovery then being 38·4 lb. of black tin per ton, and the price realized £89 per ton of concentrate. The improved values at the 310 fathom level west of Daubuz's shaft have resulted in increased returns, the sales for the 4 weeks ended May 29 being 49½ tons of concentrate from 2036 tons of ore milled, or a recovery of 54 lb. per ton. The average price must certainly be £20 per ton higher than in 1915, so that a fair profit is now presumably being earned.

At Dolcoath the improvement is in the bottom of the mine at the 550 fathom level, where in the past a good deal of development has been done with disappointing results. The ore now being broken at this point averaged 64 lb. of black tin per ton, and as the ground is easily accessible and can be comparatively cheaply worked, the improvement, if maintained, will be of some consequence.

PERSONAL.

H. FOSTER BAIN has been in the Belgian Congo and Rhodesia, and sailed from Capetown on June 10.

M. M. BARNEY was killed in action on April 27. He was an officer in the 253rd company of the Royal Engineers.

H. B. BATEMAN is serving with the troops now stationed at Calabar, West Africa.

LUCIEN I. BLAKE, known as the inventor of an electrostatic process of ore separation, died at Boston on May 4.

F. A. BLAKESLEE is here on leave from Obuasi, West Africa.

G. H. BLENKINSOP is in Prieska, in the Cape Province, where he is re-opening the New Areachap copper mine.

C. W. BOISE is in Spain.

A. H. BROMLY has been appointed to an inspectorship under the Ministry of Munitions.

J. PARKE CHANNING, CHRISTOPHER R. CORNING, and CHARLES F. RAND have returned to New York from a visit to Cuba.

ARTHUR E. DRUCKER has returned from the Frontino & Bolivia mine, Colombia.

CHESTER A. FULTON has opened an office at Havana, Cuba.

J. L. GALLARD was here on leave from the front for a few days at the end of May.

SIR W. E. GARFORTH is acting as president of the Institution of Mining Engineers during Sir Thomas Holland's absence in India on Government work.

RICHARD HAMILTON has been re-elected president of the Chamber of Mines of Western Australia for the nineteenth year in succession.

A. C. HOARE has been appointed research chemist for the Morgan Crucible Company.

J. D. HOFFMANN has left for Petrograd.

J. WINCHESTER HOLMAN, president of the company owning the *Mining and Engineering World* of Chicago, died on May 10 at the early age of 45.

FRANK G. JANNEY, head of the concentrating departments of the Utah Copper, Chino, Ray, and other Jackling companies, died on May 12, after an operation for appendicitis. He was well known as the inventor of a classifier that bears his name.

DAVID STARR JORDAN, for many years head of the Stanford University, California, retires from the position of chancellor at Midsummer, having reached the age of 65, the statutory limit.

R. M. KEENEY, well known for his researches in electro-metallurgy, has left the United States Bureau of Mines to join the Snyder Electric Furnace Company.

ROBERT A. KINZIE is examining tungsten and vanadium properties near Globe, Arizona.

NEWTON B. KNOX has gone to the United States on a short trip.

A. F. KUEHN has postponed his return from the Burma Corporation's mines, and will stay there for some time.

H. W. LAKE and DAVID CURRIE have dissolved partnership. The firm of Lake & Currie will be continued by H. W. LAKE. During his absence at the front, DAVID CURRIE, assisted by H. E. NICHOLLS, will conduct the business on his behalf.

R. B. LAMB has spent several weeks at the Oatman gold-mining district of Arizona.

FRANCIS CHURCH LINCOLN, of the University of Nevada, is paying another visit to Peru and Bolivia.

ROSS K. MACARTNEY has been appointed manager of the Rhodesia Broken Hill Company.

G. MACFARLANE has returned from West Africa.

WALTER MACLACHLAN is going to New York.

H. F. MARRIOTT has returned from South Africa.

W. H. MATTHEWS is retiring from the position of Chief Inspector of Mines for South Australia.

W. W. MEIN and KARL HOFFMANN have concluded their investigation of the Grootvlei property in the Far East Rand, and sailed from Capetown on May 27 on the steamer *Calcutta* direct for New York.

M. H. MERRISS has been appointed superintendent of the Raritan electrolytic refinery at Perth Amboy belonging to the Anaconda Copper Company.

CHARLES OLDEN is here from the Rakha Hills copper mine, Chota Nagpur, India.

CHARLES O'CONNELL has returned to the Tough Oakes mine, Kirkland Lake, Ontario, after having stayed in California for several months for the benefit of his health.

HENRY C. PERKINS and HENNEN JENNINGS are intending to sail from Seattle for Juneau on June 20, in order to make an investigation of the Treadwell group of mines.

SIR LIONEL PHILLIPS has returned to London on the conclusion of a short visit to South Africa.

R. E PROSSER, of the Allis-Chalmers Co., is at the Dunderland mines, Norway.

L. D. RICKETTS was married on April 26 to Mrs. A. W. Greenway, of Warren, Arizona.

GUY C. RIDDELL has left East Helena, Montana, to take a position with the Broken Hill Associated Smelters at Port Pirie.

WILLIAM RUSSELL, of the Dorr Company, is in Kasaki, Russia.

ANTONIO SABIONCELLO has been appointed manager of the Pulacayo mine of the Compania Huanchaca de Bolivia.

GEORGE W. SCHNEIDER has gone to Bolivia as general manager of the Bolivian Gold Exploration Company.

R. W. SCHULTZ, lately with the Mond Nickel Company, has joined the metallurgical staff of Minerals Separation Limited.

G. HILDICK SMITH is acting manager of the Bantjes mine in the west Rand.

CHARLES SPEARMAN has been appointed manager of the Renfrew molybdenite mines at Mount St. Patrick, Ontario.

NORMAN STINES sailed from New York for London on June 14.

P. F. SUMMERS has been appointed steel-works chemist for the London Foundry Co., Brimsdown.

MAJOR J. W. TEALE has received the D.S.O. in recognition of services during the evacuation of the Gallipoli peninsula. With limited resources he constructed the pier at which practically the whole of the guns and stores were embarked, and he was in charge of the destruction of all the ammunition and other supplies left behind.

GEORGE G. THOMAS has been appointed manager of the Dome Lake mine, Porcupine, Ontario.

W. E. THORNE is retained by the Lenskoie company at Bodaibo, Siberia, in charge of extensive drilling operations.

ARCHIBALD W. WILSON, recently on the staff of the Mount Morgan mine, Queensland, is attached to the Royal Army Medical Corps in Egypt. He had previously been through the Gallipoli campaign.

L. J. WILMOTH is expected from Ashanti.

AMONG the recipients of Birthday Honours are to be found J. J. H. TEALL, lately head of the Geological Survey, G. T. BEILBY, the maker of cyanide, and GEORGE P. DOOLETTE, one of the pioneers of mining in Western Australia, who have been made Knights.

METAL MARKETS

COPPER.—During the earlier half of the month of May the standard market gathered strength, although with light trading, until on the 16th £145 was realized for cash, and £143 for three months. From that date the fall has been rapid, and on the 27th the quotation was reduced to £121 cash and £120 three months. The position is exceedingly sensitive, the result of restricted trade. By the end of May the price recovered £5. In electrolytic copper the American producers have carried through a large deal with the allied governments, and are once more put in a very independent position for some time to come. Consumers both here and in America have been induced to follow the Government's lead, with the result that they all bought together, and drove the American price up to 30 to 32 cents per lb. Having bought, as it were, in a body, the market was then left bare of purchasers, and as some producers were disposed to take advantage of these favourable prices by selling ahead, the quotation came tumbling down again to 27½ to 29 cents. In this country electrolytic has ruled between £152 and £160, and down again as low as £138. Dealing is so light, however, that prices are little more than nominal, and it is not always possible to deal at the published figures.

An agreement has been reached among American consumers for controlling prices, but details have not been made public. With prices at their present level the necessity for such a combination is not apparent. The month of May closed with a very unsettled market. Until steadiness returns buyers are likely to hold off. Most of them hold stocks and can afford to wait.

Average prices of cash standard copper: May 1916, £135. 9s. 11d.; April 1916, £124. 4s.; May 1915, £77. 14s. 3d.

Copper sulphate is quoted at £55. The following are quotations for copper and brass on June 7: Tough copper £138 per ton, best selected £142, American electrolytic wire bars £141, solid drawn tubes 20¼d. per lb., brazed tubes 20¼d., wire 20½d., yellow metal 19d. Brass: Solid drawn tubes 18d. per lb., brazed tubes 20d., rods 18½d., sheets 18½d., wire 18d. The daily London prices of standard and electrolytic copper are given in our pages of statistics.

SPELTER.—This metal shows weakness. The official quotation has declined from £107 to £70–£60. No satisfactory explanation of the fall is forthcoming, but presumably the competition of the newly erected smelters is showing itself. Inquiry is still coming in from the Allies for high class qualities.

Average prices of good body brands: May 1916, £89. 11s. 4d.; April 1916, £94. 1s. 8d.; May 1915, £67. 19s.

LEAD.—Very little business is passing. Arrivals have been normal, but the bulk of the metal finds its way direct to munition factories, and it does not come on the market. The quantities bought by the general trade continue insignificant. Following the trend in other markets, prices have declined after touching £34, but the market has become sensitive at the lower figures, and is affected disproportionately to the importance of transactions involved. The condition of supplies remain much as they were with Mexican supplies cut off. American demand absorbs the whole of the local production, which seems incapable of sufficient expansion to provide a surplus for export surplus. The latest American price is 7 c., a reduction of 1 c. from the highest quotation. This is much above English parity. The Australian production does not come on the open market. The bulk of the Spanish output is still being delivered direct to the allied governments. The export of lead to British colonies has been put under government control.

Average prices of soft foreign pig lead: May 1916, £32. 19s. 5d.; April 1916, £34. 8s.; May 1915, £20. 7s. 2d.

TIN.—The tin market has shown a downward trend. With prices starting at £200. 15s. cash, and £199. 10s. three months, in the early days of May, the quotation declined to £185. 15s. at the close. Home consumers have been buying steadily, if not in large volume. Only 55% of the capacity of the tinplate mills is available, owing to labour shortage. Chinese tin is out of the market as the rise in silver renders exchange unprofitable. There has been a good demand for English tin, which stands at a comparative premium. Some good orders have been given out by Russia, and a regular business has started between Java and the Straits and Vladivostok. In France good premiums have been paid for spot tin, and the quantities stored there a short time ago have been sold, while the shipments afloat are small. Italy is also a buyer, but trading is restricted by the difficulty of getting export permits. Good quantities of tin are being put into London warehouses, but there is still some premium on spot metal. The shipments of Banca are 2300 tons, which are well over current production. They will probably decrease from July onward. In America the deliveries are given as 5400 tons, which testifies to the consumption there.

Average prices of cash standard tin: May 1916, £196. 11s. 9d.; April 1916, £199. 10s.; May 1915, £162. 18s. 6d.

ANTIMONY.—This metal is still controlled by the Government and no public quotation can be given. The average price paid will probably vary from £100 to £120 per ton. Antimony crude has been quoted at £65, and ore at 10s. to 11s. per unit. Larger amounts are coming from Bolivia. In the United States the pressing demand has slackened, and the price is now about the same as the English figure mentioned above.

QUICKSILVER.—The official price of Spanish quicksilver remains at £16. 15s. per flask of 75 lb. In America the price has eased considerably, and the market is reported as dull. The quotation per flask is \$90, as compared with \$135 to \$150 a month ago.

BISMUTH.—The Government controls the English supply, and Johnson, Matthey & Co. are not giving any public quotation. For a long time the price was 10s. per lb., but probably 12s. to 15s. is now being paid.

CADMIUM.—8s. per lb.

PLATINUM.—This metal has been for some time controlled by the Government, which has fixed the price at 190s. per oz. Johnson, Matthey & Co. act as purchasing agents for the Government. In America the scarcity is not as acute as it was, and the price has eased to \$80 per oz.

NICKEL.—The quotation continues at £225 per ton, and in America at 45c. to 50c. per lb. The Canadian refinery of the International Nickel Co. is being built, and the nickel required for Canadian and British consumption will be produced there before long.

ALUMINIUM.—This metal is still controlled by the Government and the price is nominal. Possibly £150 per ton may be taken as an average price. In America the price remains at 58c. to 60c. per lb., but little or no metal is sold outside contracts.

IRON.—The Government continues its campaign against speculation in the iron market, and trouble was caused for a short time in this connection on the Glasgow Metal Exchange. The official maximum price for No. 3 Cleveland iron has been raised from 82s. 6d. to 87s. 6d. per ton, and probably the same concession will be granted for other brands. In particular, it is expected that the maximum price of hematite will be raised. The stocks of pig iron continue to decrease, and government aid in re-starting additional furnaces is being sought. The scarcity of East Coast hematite is more pronounced than ever, and none is available for export; the price for home consumption is 122s. 6d., and nominally for export 140s. The home iron trade is extremely busy, and the gradual withdrawal of restrictions on export has assisted the overseas trade.

MANGANESE.—The market quotation for Indian ores on 50% basis for this year's delivery continues at 2s. 6d. per unit, c.i.f. England; and that for Brazilian ores, on similar terms, 4s. per unit. The price of 80% ferro-manganese for home orders continues at £25 per ton, and for export orders £30 to £40, according to destination. The anxiety in America as to supplies of ferro-manganese have been allayed to some extent, and £65 per ton is now paid for supplies not covered by contract, as compared with £85 a month ago. Metallic manganese is quoted at Sheffield at 2s. 8d. per lb., 90 to 95% carbonless. In our Mining Digest this month we publish information relating to Brazilian manganese deposits, and in Review of Mining we record that West Africa will shortly be a producer.

MOLYBDENUM.—This metal is still under government control, and the price of molybdenite 90% MoS_2 continues at 105s. per unit. The price in America of molybdenite, 80 to 90% MoS_2, is \$1·50 per lb. Ferro-molybdenum, 65 to 85% Mo, is quoted at Sheffield at 18s. per lb.

TUNGSTEN.—This metal remains under government control, with prices for wolfram and scheelite ores, 70% WO_3, at 55s. per unit. High-speed tool-steel is quoted at 2s. 10d. per lb. 14% tungsten, and 3s. 10d. 18% tungsten. Scrap is repurchased at 5d. per lb. for millings and turnings, and 6d. per lb. for bar ends. Ferro-tungsten is quoted at Sheffield at 6s. 1d. per lb., 80 to 90% low carbon; tungsten metal powder 6s. 3d. per lb., 96 to 98%.

TITANIUM.—Ferro-titanium 15 to 18% Ti, and 5 to 8% carbon, 6½d. per lb.; 23 to 25% Ti carbonless, 1s. 5d. per lb.

VANADIUM.—Ferro-vanadium, 15s. per lb. of vanadium contained.

FERRO-SILICON.—Basis 75% Si £48 per ton, scale 8s. per unit; 45 to 50% Si, basis 45%, £28. 10s., scale 7s. 6d. per unit.

COBALT.—96 to 98%, 8s. per lb.

CHROMIUM.—Chalas & Sons give the following quotations for chrome ores: New Caledonia ore 53 to 55%, basis price for 50% Cr_2O_3, £1. 16s. per ton f.o.b., scale 2s. Baluchistan ore, 53 to 55%, f.o.b., basis price for 50% Cr_2O_3, £3, scale 2s. No quotation for Rhodesia chrome ore. At Sheffield, the quotations for ferro-chrome are: 4 to 6% carbon, basis 60%, £35 per ton, scale 10s. per unit; 6 to 8% carbon, basis 60%, £29. 10s. per ton, scale 10s. per unit; 2% carbon, 60%, £86 per ton.

SILVER.—The sudden boom in silver reported last month, when the price rose from 28½d. to 37d. per standard ounce, proved to have been based on transient conditions. On China coming out as a seller, weakness was soon exhibited and the price steadily dropped to 31d. Later the tone became stronger owing to Indian bears being caught short, and the quotation advanced 32d. Another sudden fall brought the price down to 30d.

PRICES OF CHEMICALS. June 7.

		£	s.	d.
Acetic Acid, 40%	per cwt.	3	15	0
,, 60%	,,	5	15	0
,, Glacial	,,	10	0	0
Alum	per ton	12	0	0
Alumina, Sulphate of	,,	15	10	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	30	0	0
,, Chloride of, grey	per cwt.	1	13	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	55	0	0
,, Phosphate of	,,	90	0	0
,, Sulphate of	,,	16	0	0
Arsenic, White	,,	31	10	0
Barium Chloride	,,	30	0	0
,, Carbonate	,,	7	0	0
,, Sulphate	,,	5	10	0
Bisulphide of Carbon	,,	30	0	0
Bleaching Powder, 35% Cl.	,,	18	10	0
Borax	,,	28	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	1	10	0
Copper, Sulphate of	,,	55	0	0
Creosote	per gal.		0	4
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		13	9
Iron, Sulphate of	per ton	3	10	0
Lead, Acetate of, white	,,	105	0	0
,, Chemical Sheet Metal	,,	42	0	0
,, Nitrate of	,,	80	0	0
,, Oxide of, Litharge	,,	45	0	0
,, White	,,	47	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	10	10	0
Oxalic Acid	per lb.		1	9
Phosphoric Acid	,,			11
Potassium Bichromate	,,		2	0
,, Carbonate	per ton	160	0	0
,, Chlorate	per lb.		2	7
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb		9	0
,, Prussiate, Yellow (Ferricyanide)	,,		4	6
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	4
,, Acetate	per ton	80	0	0
,, Bicarbonate	,,	6	10	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	5	0
,, Hydrate, 76%	,,	17	10	0
,, Hyposulphite	,,	16	0	0
,, Nitrate, 95%	,,	18	10	0
,, Phosphate	,,	29	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	12	6
,, Sulphide	,,	27	0	0
Sulphur, Roll	,,	12	0	0
,, Flowers	,,	12	10	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tartaric Acid	per lb.		3	9
Tin Chloride (Tin Crystals)	,,		1	4
Zinc Chloride, solution 100°T.	per ton	32	0	0
Zinc Sulphate	,,	30	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
July 1915	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122
November	753,605	27,408	781,013	3,317,534
December	755,101	26,010	781,111	3,317,949
Year 1915	8,772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063
March	768,714	27,975	796,689	3,384,121
April	728,399	26,273	754,672	3,205,643
May	751,198	26,483	777,681	3,303,377

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9,468	970	219,864
March	203,575	9,588	917	214,080
April	199,936	9,827	938	210,701
May	194,765	9,811	1,459	206,035

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
July 1915	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229
December	2,410,841	26 5	17 10	8 2	985,361
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
January 1916	2,449,518	26 1	17 10	7 10	962,120
February	2,297,276	26 8	18 4	8 0	924,310
March	2,455,019	26 5	18 1	8 0	979,234

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	313,769	144,034	137,739
March	299,686	335,368	153,770	150,987
April	315,541	339,386	149,978	135,976
May	318,898	—	142,123	—
June	322,473	—	135,289	—
July	336,565	—	140,290	—
August	344,493	—	139,364	—
September	321,085	—	135,744	—
October	339,967	—	141,771	—
November	313,160	—	122,138	—
December	331,376	—	158,323	—
Total	3,823,166	1,307,109	1,706,473	565,281

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
Total, 1915	17,277	1,192,790	1,210,067	5,140,189
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,1·8	67,970	288,717
March	5,600	88,393	93,993	399,255
April	2,926	87,601	90,527	384,532
May	577	83,301	83,878	356,289

Australian Gold Production.

	Victoria.		Queensland.		New South Wales
	1915	1916	1915	1916	1916
	£	£	£	£	£
January	69,900	89,900	43,770	66,700	39,000
February	122,300	76,500	85,850	79,050	30,000
March	142,800	103,600	98,550	76,920	36,000
April	109,300	60,000	97,320	83,300	63,000
May	102,900	—	130,470	—	19,000
June	134,200	—	90,500	—	—
July	154,800	—	88,830	—	—
August	80,300	—	93,050	—	—
September	138,900	—	79,470	—	—
October	111,700	—	91,800	—	—
November	115,300	—	77,780	—	—
December	115,400	—	81,170	—	—
Total	1,397,800	330,000	1,078,560	305,970	188,000

Production of Gold in India.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	186,475
April	191,215	189,197	196,747	192,208
May	190,607	193,031	199,786	193,604
June	189,322	192,224	197,447	—
July	193,859	195,137	197,056	—
August	193,998	196,560	197,984	—
September	191,642	195,843	195,952	—
October	194,314	198,191	195,531	—
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	947,701

Daily London Metal Prices

in £ per long ton.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard
May	£ s. d.	£	£ s. d	£	£ s. d.
1	133 5 0	145	35 15 0	99	200 5 0
2	134 0 0	145	34 10 0	98	201 2 6
3	135 5 0	150	34 12 6	98	200 2 6
4	137 5 0	150	34 12 6	98	200 2 6
5	137 0 0	152	34 2 6	98	200 17 6
8	139 0 0	154	34 5 0	98	200 12 6
9	139 0 0	155	34 10 0	98	199 12 6
10	140 0 0	156	34 5 0	98	198 12 6
11	140 10 0	156	34 0 0	98	198 0 0
12	140 10 0	158	33 15 0	96	198 2 6
15	143 5 0	160	33 10 0	96	196 17 6
16	145 5 0	160	33 15 0	95	197 7 6
17	145 5 0	160	32 10 0	95	197 5 0
18	143 0 0	160	31 12 6	95	197 7 6
19	137 10 0	160	31 10 0	95	197 7 6
22	137 10 0	160	31 12 6	95	196 5 0
23	134 10 0	160	31 10 0	95	193 5 0
24	130 15 0	156	31 7 6	95	192 5 0
25	129 5 0	154	31 7 6	95	192 15 0
26	121 5 0	150	31 5 0	90	193 5 0
29	126 5 0	150	31 10 0	80	193 5 0
30	122 5 0	144	31 10 0	80	190 5 0
31	122 5 0	144	31 15 0	80	187 10 0
June					
1	121 5 0	142	31 15 0	75	187 10 0
2	121 5 0	142	32 0 0	70	186 0 0
5	123 10 0	142	31 17 6	73	183 10 0
6	124 0 0	144	32 0 0	76	183 0 0
7	123 10 0	144	32 5 0	73	184 10 0
8	123 10 0	144	32 7 6	73	187 10 0
9	123 10 0	144	31 15 0	71	187 15 0

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1915	April 1916	May 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	2,504	3,284	15,912
,, Matte and Precipitate	38,372	7,980	1,461	17,727
,, Metal (unwrought and part wrought)	180,368	7,464	8.760	48,250
Copper and Iron Pyrite	903,401	105,234	93,555	453,737
Tin Concentrate	44,748	3,546	2,268	13,677
,, Metal	38,896	4,670	4,268	15,172
Manganese Ore	377,324	45,500	42,068	174,666
Lead, Pig and Sheet	256,476	14,723	13,785	76,378
Zinc (spelter)	74,520	2,819	2,838	15,236
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	750,000	—	1,509,290

Stocks of Copper.
Reported by Henry R. Merton & Co. Ld. Long tons.

	Mar. 31, 1916	April 30, 1916	May 31, 1916
	Tons	Tons	Tons
Standard Copper in England	2,093	1,052	1,857
Fine Copper in England	35	1,601	935
,, ,, Havre	3,400	4,570	3,770
,, ,, Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*
,, ,, Afloat from Chile	1,750	3,700	3,000
,, ,, ,, from Australia	4,800	5,000	4,100
Total Visible Supply	17,201	21,046	18,785
In other European Ports Estimated	—	—	—

* As on July 31, 1914, but presumably present stock nil.

Exports of Copper from United States
Reported by United States Customs.

1915	Long tons	1915	Long tons	1916	Long tons
January	28,197	July	16,812	January	21,863
February	12,066	August	16,289	February	20,548
March	29,725	September	14,327	March	24,006
April	20,481	October	26,153	April	19,980
May	25,785	November	19,396	May	14,700
June	15,751	December	32,936	June	—
		Total 1915	257,915	Total 1916	101,097

Stocks of Tin.
Reported by A. Strauss & Co. Long tons.

	Mar. 31, 1916	April 30, 1916	May 31, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	619	1,804	1,862
Ditto, Landing and in Transit	1,025	1,054	650
Other Standard, Spot and Landing	886	1,005	1,862
Straits, Afloat	4,620	3,858	2,960
Australian, Afloat	325	384	500
Banca, on Warrants	—	—	—
Ditto, Afloat	4,340	4,762	4,375
Billiton, Spot	17	7	—
Ditto, Afloat	333	217	123
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,105*	1,555*	1,010*
Afloat for United States	4,405	3,885	5,190
Stock in America	2,746	2,756	2,468
Total Stock	20,421	21,287	21,000

* Including 705 tons on board enemy's ships either captured or lying in neutral ports.

Shipments and Imports of Tin.
Reported by A. Strauss & Co. Long tons.

	Year 1915	April 1916	May 1916	1916 to date
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	2,475	1,415	10,620
Straits to America	31,565	1,260	2,145	12,200
Straits to Continent	11,024	950	405	3,345
Australia to U.K.	2,481	245	312	1,442
U.K., Holland, and Continent to America	14,967	1,115	1,928	5,778
Imports of China Tin into U.K. and America	3,012	60	1,080	1,325
Imports of Bolivian Tin into Europe	22,591	1,730	982	5,801

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	528
March	247	510	502	418	547
April	141	430	482	444	486
May	144	360	480	357	—
June	121	321	460	373	—
July	140	357	432	455	—
August	201	406	228	438	—
September	196	422	289	442	—
October	256	480	272	511	—
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	2,092

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3.313
March	3,196	3,562	3,839	3,653	3,696
April	3,904	4,066	4,087	3,619	3,177
May	4,277	4,319	4,135	3,823	3.722
June	3,472	3,993	4,303	4,048	—
July	4,234	4,245	4,582	3,544	—
August	4,454	4,620	3,591	4,046	—
September	4,115	4,379	3,623	3,932	—
October	3,905	4,409	3,908	3,797	—
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50.127	49,042	46.767	18.224

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
September 13, 1915	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3
October 11	166	£13,620	£82 1 0
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0
December 20	181½	£16.941	£93 6 10
Total, 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18.122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179¼	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5
March 13	182	£19,921	£109 9 2
March 27	190½	£21,437	£112 10 6
April 10	185½	£21,517	£115 19 11
April 25	164	£18,504	£112 16 7
May 8	181	£20,852	£115 4 2
May 22	190	£20,986	£110 9 0
June 5	175	£18.286	£104 9 10

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	June 1 1915	May 2 1916	June 5 1916
RAND:			
Bantjes	10	15	14
Brakpan	52	78	82
Central Mining (£12)	135	130	127
Cinderella	4	7	6
City & Suburban (£4)	46	35	37
City Deep	63	78	80
Consolidated Gold Fields	30	28	27
Consolidated Langlaagte	35	32	35
Consolidated Main Reef	19	19	19
Consolidated Mines Selection (10s.)	10	17	17
Crown Mines (10s.)	86	54	61
Daggafontein	7	16	15
D. Roodepoort Deep	18	14	15
East Rand Proprietary	31	15	14
Ferreira Deep	46	36	30
Geduld	31	46	45
Geldenhuis Deep	21	22	24
Gov't Gold Mining Areas	21	35	37
Heriot	65	• 52	52
Jupiter	6	7	6
Kleinfontein	25	29	27
Knight Central	9	15	12
Knight's Deep	25	22	29
Langlaagte Estate	18	20	19
Luipaard's Vlei	8	9	9
Main Reef West	7	8	7
Meyer & Charlton	107	107	111
Modderfontein B	100	127	137
Modder Deep	86	126	135
Modderfontein, New (£4)	294	330	340
Nourse	26	16	15
Rand Mines (5s.)	98	66	70
Randfontein Central	13	11	11
Robinson (£5)	34	20	20
Robinson Deep	26	20	20
Rose Deep	36	25	24
Simmer & Jack	8	7	7
Simmer Deep	1	2	3
Springs	23	53	54
Van Ryn	60	45	45
Van Ryn Deep	53	65	70
Village Deep	37	32	32
Village Main Reef	32	20	17
Witwatersrand (Knight's)	62	55	60
Witwatersrand Deep	34	24	25
Wolhuter	14	11	11
RHODESIA:			
Cam & Motor	15	17	13
Chartered	11	10	12
Eileen Alannah	9	9	10
Eldorado	14	9	11
Enterprise	6	6	5
Falcon	11	10	13
Giant	7	7	7
Globe & Phœnix (5s.)	27	23	24
Lonely Reef	22	25	24
Shamva	37	34	35
Wanderer (5s.)	1	1	1
Willoughby's (10s.)	6	5	5
OTHERS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	237	210	220
Glynn's Lydenburg	10	10	17
Jagersfontein	57	66	67
Premier Diamond Defer'd (2s. 6d.)	97	100	102
Sheba (5s.)	4	[illegible]	2
Transvaal Gold Mining Estates	36	25	23
WEST AFRICA:			
Abbontiakoon (10s.)	9	8	7
Abosso	9	9	10
Ashanti (4s.)	15	19	18
Broomassie (10s.)	1	½	½
Prestea Block A	12	10	9
Taquah	14	19	18
WEST AUSTRALIA:			
Associated Gold Mines	5	5	5
Associated Northern Blocks	4	3	4
Bullfinch	6	4	5
Golden Horse-Shoe (£5)	46	36	37
Great Boulder Proprietary (2s.)	16	13	14
Great Boulder Perseverance	1	1	1
Great Fingall	5	2	2
Ivanhoe (£5)	44	44	44
Kalgurli	36	12	12
Sons of Gwalia	17	14	16
Yuanmi	2	2	2

GOLD, SILVER, *cont.*	June 1 1915	May 2 1916	June 5 1916
OTHERS IN AUSTRALASIA:			
Blackwater	15	15	15
Consolidated Gold Fields of N.Z.	12	11	11
Mount Boppy	12	13	11
Mount Morgan	46	44	42
Progress	7	5	5
Talisman	22	12	12
Waihi	40	34	37
Waihi Grand Junction	23	19	19
AMERICA:			
Alaska Treadwell (£5)	144	130	127
Buena Tierra	13	14	12
Camp Bird	5	8	10
Canadian Mining	9	12	12
Casey Cobalt	11	7	7
El Oro	7	10	10
Esperanza	7	12	11
Frontino & Bolivia	9	9	11
Le Roi No. 2 (£5)	14	10	11
Mexico Mines of El Oro	72	80	82
Oroville Dredging	12	16	16
Plymouth Consolidated	17	23	23
St. John del Rey	15	15	15
Santa Gertrudis	7	12	15
Tomboy	24	23	23
RUSSIA:			
Lena Goldfields	36	32	32
Orsk Priority	8	16	16
INDIA:			
Champion Reef (2s. 6d.)	11	8	7
Mysore (10s.)	85	79	78
Nundydroog (10s.)	25	27	29
Ooregum (10s.)	25	22	22
COPPER:			
Anaconda (£10)	131	357*	350*
Arizona Copper (5s.)	—	36	40
Cape Copper (£2)	62	79	75
Chillagoe (10s.)	½	½	½
Cordoba (5s.)	4	4	4
Great Cobar (£5)	2	3	3
Hampden Cloncurry	25	42	44
Kyshtim	47	45	45
Messina (5s.)	10	11	11
Mount Elliott (£5)	59	80	85
Mount Lyell	25	29	30
Rio Tinto (£5)	1192	1240	1220
Sissert	21	19	19
South American Copper (2s.)	15	15	16
Spassky	51	39	40
Tanalyk	47	40	42
Tanganyika	26	39	50
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	20	32	30
British Broken Hill	24	27	25
Broken Hill Proprietary (8s.)	42	60	59
Broken Hill Block 10 (£10)	22	24	24
Broken Hill North	42	48	48
Broken Hill South	145	160	170
Sulphide Corporation (15s.)	19	23	25
Zinc Corporation (10s.)	14	14	14
ASIA:			
Burma Corporation	37	45	52
Irtysh Corporation	36	39	40
Russian Mining	18	15	17
Russo-Asiatic	100	101	102

TIN:	June 1 1915	May 2 1916	June 5 1916
NIGERIA:			
Bisichi	6	8	9
Ex-Lands Nigeria (2s.)	1	2	1½
Mongu	9	9	9
Naraguta	16	17	15
N. Nigeria Bauchi (10s.)	2	2	2
Rayfield	4	6	6
Ropp (4s.)	17	16	17
OTHER COUNTRIES:			
Aramayo Francke	27	26	26
Briseis	5	5	5
Cornwall Tailings	15	4	4
Dolcoath	7	9	13
East Pool	9	32	34
Gopeng	30	31	31
Pahang Consolidated (5s.)	7	10	10
Renong Dredging	21	30	30
Siamese Tin	54	57	57
South Crofty (5s.)	5	14	15
Tekka	60	60	60
Tronoh	30	42	34

* Denomination of shares recently changed from £5 to £10.

THE MINING DIGEST

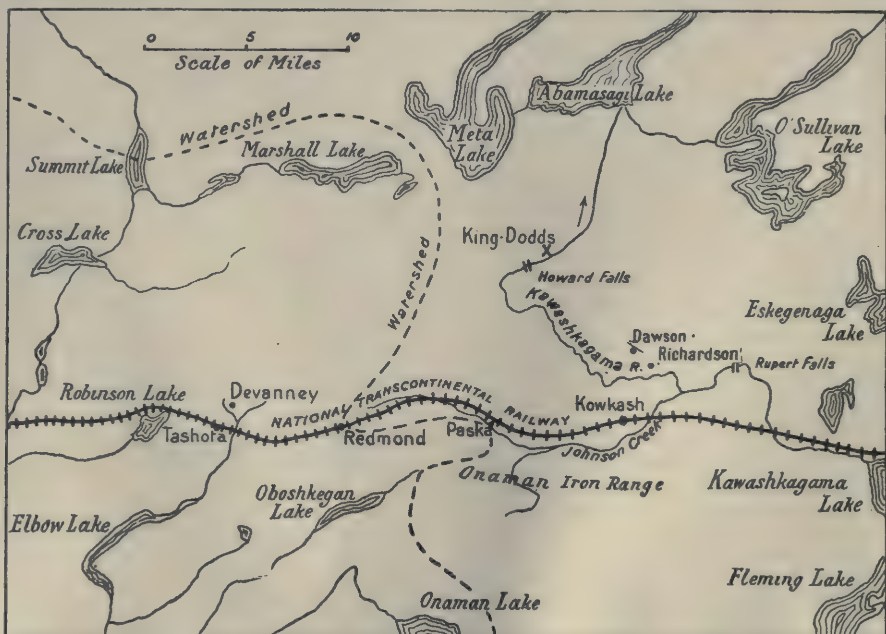
A PRECIS OF MINING TECHNOLOGY, DEVELOPMENT, AND LITERATURE

[In this department will be found listed the more important articles and miscellaneous publications appearing each month which deal with metal mining and non-ferrous mineralogy, the more significant publications being abstracted or reviewed. Copies of the originals can be obtained through the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.]

THE KOWKASH GOLD DISTRICT, ONTARIO.

A report by Percy E. Hopkins on the Kowkash gold district has been published by the Ontario Bureau of Mines. This is based on observations made in September and October of last year. Mr. Hopkins' visits followed soon after the discovery of gold made by E. W. King Dodds on August 21, details of which have already appeared in our pages, notably in our issue of October. The accompanying map shows details of the district, but in order to fix the position it is desirable to say that it is about 100 miles north of the central part of Lake Superior, 50 miles east of Lake Nipigon, and 300 miles west of Porcupine. The Kawash-kagama river flows in a northeast direction, and joins the Albany, which discharges into Hudson Bay; the drainage of the land in the southwestern part of the map is into Lake Superior. The name 'Kowkash' is a euphonious abbreviation of Kawashkagama, the name of the river, which in turn was an official abbreviation of the Indian name 'Kawa-kashkagama.' The district was first described in 1870 by Robert Bell of the Geological Survey of Canada. Subsequently another Survey report was made in 1900 by E. V. Neelands, who indicated that the geology was such that prospecting for gold was warranted. The first prospecting work was not, however, undertaken in connection with gold, but with the object of testing iron deposits in the Onaman range, south of Johnson creek. These iron deposits were extensively tested on behalf of the United States Steel Corporation in 1906-7, but the magnetite and hematite proved to be of a lower grade than was acceptable then. The discovery of gold was made by E. W. King Dodds while walking over a rocky hill below Howard falls, that had been laid bare by a fire. Within three weeks many prospectors had staked 100 claims in the neighbourhood. No further gold discoveries were made there, but shortly afterward gold was found at two other centres, one about three miles north of Kowkash station, where the Richardson and Dawson claims were pegged, and the other near Tashota, 22 miles west of Kowkash, where the Devanney claim has been recorded. Gold has also been found near Redmond station and on O'Sullivan lake.

The country has an average elevation of about 1000 ft. above the sea, and there is not more than 150 ft. between the highest ground and the valleys. The watershed is never a ridge, but is more often a swamp or lake. The area consists of Pre-Cambrian rocks similar to those found at Porcupine and elsewhere in Northern Ontario. Rocks of the Keewatin age are predominant,



MAP OF PART OF NORTHERN ONTARIO, SHOWING POSITION OF KOWKASH AND TASHOTA.

and there are also Timiskaming sediments, and later intrusions of felspar-porphyry, granite, and diabase. The Keewatin consists chiefly of massive fine-grained chlorite and hornblende rocks, which are in places altered to schists. Their dip is nearly vertical. As already mentioned an iron formation is found on the Onaman range. Cutting the greenstones and closely associated with the iron formation are narrow dikes and flows of quartz-porphyry. The porphyry contains numerous white quartz phenocrysts the size of peas, and some felspar phenocrysts, in a fine-grained greyish-white groundmass. It also contains some quartz stringers, and it is schistose in places. Granite and gneiss are found, possibly of Laurentian age, but some are of later age. Conglomerates and slates similar to the Timiskaming sediments at Porcupine and Kirkland Lake are found two miles below Howard Falls. These strike 65° east and dip vertically. The pebbles of the conglomerate are rounded and consist of chert, quartz-porphyry, amygdaloidal basalt, and granite-gneiss. Cutting these older rocks are massive granite areas, probably of Algoman age. Grey granite is found at Tashota, and red granite at Redmond. Quartz-diabase dikes are found at many places, for instance at Tashota and the King Dodds, and are similar to the Keweenawan diabase at Cobalt. Large areas of diabase are found round Lake Nipigon, and indications point to their providing a suitable field for the silver prospector. The region has been much glaciated, the ice movement having been from the north-east.

At the King Dodds, the quartz vein conforms in strike and dip with the country rock, the strike being 10° south of east and the dip 75° to the north. On the surface the vein was from 1 to 5 in. thick. An abundance of free gold occurred for 4 or 5 ft. along the hanging wall. On the north side of the vein is a rusty schist band, 6 in. wide, heavily impregnated with pyrite. The wall rock is pillow lava, altered in places to schist. Numerous quartz-porphyry dikes up to 30 ft. wide occur on the claim. By the end of October the vein had been stripped for 100 ft. and a 14 ft. pit had been sunk. The showing of free gold disappeared a few feet down. At the bottom of the pit the vein is 2 in. wide with 1 ft. of pyritous schist on the foot-wall, but no gold was visible. A channel sample across 12 in. of the schist gave an assay of $2 gold.

At the Richardson claim, the quartz vein is 2 in. thick over a length of 200 ft. It strikes 85° east and dips 70° south. The rock is Keewatin pillow lava. Near the vein is a biotite granite dike 6 ft. wide. Coarse gold could be seen in half-a-dozen places along the vein, and pyrite is present. The Dawson claim is about 2 miles northwest of the Richardson. The vein is lenticular and averages 1 ft. in width. Chalcopyrite, pyrite, and chalcocite are disseminated throughout the rusty quartz. The country rock is a massive green altered Keewatin diabase.

At the Devanney claim, near Tashota, the vein is lenticular, varying from a few inches up to 4 ft. in width, and it can be traced intermittently for 600 ft. The quartz is milky, in places rusty, and contains a little fine gold, and tellurides in considerable amount, together with pyrite and pyrrhotite. A polished surface of the ore shows that there are at least three tellurides present. The wall-rock is a Keewatin greenstone consisting of chlorite, calcite, and quartz.

Four miles east of Redmond, on the McFarlane claim, is a quartz-calcite vein 2 to 10 ft. wide, in a Keewatin greenstone. In a pit 11 ft. deep, a vein of galena ½ in. thick occurs in the foot-wall assaying $6 gold. The central part of the vein gave an assay of $1·20 gold.

After summarizing the information already obtained, Mr. Hopkins is of opinion that the various claims are well worth developing and that the region generally warrants the further attention of prospectors. For the benefit of our readers unversed in the geological nomenclature of the district, we may mention that in our issue of December 1915 we gave an outline of the geology of Northern Ontario.

X-RAYS AND CRYSTAL STRUCTURE.

W. H. Bragg, professor of physics in the University of London, is one of the foremost authorities on X-rays, and he has devoted special study with regard to the application of these rays to crystal structure. He delivered a lecture on this subject at the meeting of the Institute of Metals held at the beginning of May. His work has for its object the determination of the relative positions of the atoms composing the crystal. A convenient group of substances on which to begin investigations is the halogen salts of the alkali metals, or as he calls it, the rock-salt group.

The crystals of this group have a simple structure and consist of few elements associated in simple proportions. These crystals also have the advantage of belonging to a group of isomorphous members. This series, in fact, has everything to recommend it to the experimenter: its form is simple, that of the cube; its symmetry is high; it contains two elements only, in equal proportions, for example, sodium or potassium associated with chlorine or iodine; and there are several members of the series, so that the effect of changing one element at a time can be watched. The constitution of the diamond, which has also been determined, presented a rather more difficult task, because the arrangement of the atoms is not so simple as that of the rock-salt series, although its form is cubic, its symmetry is high, and it contains atoms of one kind only. Of the metals, silver and copper, and by inference gold, have been shown to possess a simple structure, in which the atoms are arranged as in the piling of shot. Bismuth and antimony have a distorted arrangement; but these two, as well as zinc, have not been completely determined. Professor Bragg has also experimented with iron.

This new field of research depends on a principle already known. When a regular train of waves falls upon a surface separating two media, part is reflected and part goes on. If the part that goes on meets another separating surface, a second portion is reflected and some of this emerges from the second medium in the same direction as the beam reflected from the first surface. It will happen in general that the two reflected beams are out of phase and to that extent destroy one another. Whether they do so or not depends upon the relation between the wave length, the angle of the inclination of the beam to the reflecting surfaces, and the distance between the surfaces. In this way are explained the colours of the soap film, of the thin layer of oil on the surface of a liquid, and of the colours of steel when being tempered. If the reflecting surfaces are many in number, not two, the effect is made more intense and at the same time more precise. This occurs in the case of the colours of the chlorate of potash crystals shown by Lord Rayleigh.

These crystals are formed of alternating layers, twinned across their surfaces of separation; and for some obscure reason, the thickness of all the layers is the same, though it varies from crystal to crystal. When white light containing all wave lengths is incident upon such a crystal, at a certain angle, then only that wave length is reflected for which the proper relation between the wave-length, angle, and spacing holds good. If the angle is altered, the wave-length which is reflected is no longer the same. Hence the beautiful play of colours which the crystal shows. It is an essential cause of the success of this effect that the wave-length and the spacing are not very different in amount.

Professor Bragg then proceeded to describe the action of X-rays in similar circumstances. These rays consist of waves which are ten thousand times shorter than the waves of light. To obtain the analogous effect it is necessary to seek for reflecting surfaces which are ten thousand times closer together than the twinning surfaces of the chlorate of potash crystals, and these are separated from one another by only the forty thousandth of an inch or thereabout. These also Nature has provided in the layers of atoms in the crystal. It may seem strange that a layer of atoms should act as a reflecting surface, but after all it is not necessary that such a surface should be continuous. A row of iron railings, for example, can act as a reflector of sound waves. A natural face of a crystal contains no doubt a layer of atoms arranged regularly; and behind the natural face are other layers all similar, and placed at regularly increasing distances behind it. Thus all the conditions for this reflection experiment are present, and it is actually found that when a pencil of X-rays of a definite wave-length are allowed to fall upon the face of the crystal, and the crystal is gradually turned round so as to alter the angle of incidence, the reflection of the beam as a whole is non-existent except when the angle is the right one. Then it flashes out strongly. When this angle is observed, the relation of the wave-length to the spacing is known.

The instrument used is called the X-ray spectrometer. It has no lenses, because X-rays cannot be refracted, and the rays are invisible. In place of the telescope there is a chamber containing gas which is ionized by the X-rays. The resulting electrical effect is observed in an electroscope. It is important to note that the measurement of the result is quantitative, so that in this respect the new spectrometer has an advantage over the old. In this way if the same X-ray is always used, it is possible to compare the spacings between the layers parallel to one after another of the natural faces parallel to the crystal; and in this way to arrive finally at the crystal structure. The instrument is not difficult to use, and the observed effects are large and precise, so that it is easy to get numerical results. The interpretation is not always so easy. One part of it comes readily, namely, the number of molecules to each unit of the pattern of the crystal, the unit being the smaller part which being reflected again and again without alteration of orientation or distance from its neighbours forms the complete crystal. For instance, the unit of pattern of potassium sulphate contains four molecules, and the unit of pattern of antimony contains two atoms. The greater difficulty lies in the determination of the way in which the atoms are arranged in the unit. These data are sufficient, but the interpretation is far from easy.

THE MANGANESE ORES OF BRAZIL.

We recorded the present position with regard to the world's supply of manganese in an Editorial last month, and we mentioned that the difficulty of obtaining Caucasian ores and restrictions in connection with the export of Indian ores had caused greater attention to be paid to Brazilian ores especially among American users, in spite of the higher price due to the greater cost of transport. A timely article on the manganese ores of the world has since come to hand, written by E. C. Harder, and published in the May *Bulletin* of the American Institute of Mining Engineers. We quote herewith Mr. Harder's account of the chief Brazilian deposits. Mr. Harder is intimately acquainted with Brazil, and in August last we gave a précis of an article by him and R. T. Chamberlin on the 'Geology of the State of Minas Geraes,' to which our readers may conveniently refer in connection with the present article. We have on several occasions also quoted Mr. Harder's accounts of the iron deposits of Brazil.

Manganese ores are found in Brazil in the states of Bahia, Minas Geraes, and Matto Grosso. Fully 95% of the production comes from the Lafayette and Miguel Burnier-Ouro Preto districts of Minas Geraes, and about 5% from Bahia. The Corumba deposits in Matto Grosso are near the head waters of the Paraguay river, and are at present unworked owing to the high cost of transport.

Manganese ore in the Miguel Burnier-Ouro Preto district was discovered in 1888 when the branch of the Central of Brazil railway from Miguel Burnier to Ouro Preto was under construction, the ore being found in one of the cuts east of Miguel Burnier. Mining operations were begun near this locality in 1894 by Costa & Almeida, at the mine known as the Usina Wigg. In 1897 another firm, Airosa & Co., started operations in the same neighbourhood. After the manganese ore discovery near Miguel Burnier, much exploration was done, and during 1896 and 1897 many deposits were discovered in the Lafayette district, among them the Barrosa, Morro da Mina, Piquery, and Sao Gonçalo. Of these the Sao Gonçalo mine commenced operating in 1900, the Piquery mine in 1902, and the Morro da Mina mine in 1904, and in 1910 the Rodeio mine east of Miguel Burnier. The Wigg and Morro da Mina mines are the principal producers in Brazil.

The ores of Minas Geraes may be separated into two classes:

(1) Those occurring in a complex of granite, gneiss, and crystalline schist;

(2) Those occurring in overlying metamorphosed sediments, with which the important Brazilian iron ores also are associated.

The deposits in the region around Lafayette belong to the first class, and those in the neighbourhood of Miguel Burnier and Ouro Preto are of the second type. The centres of the two districts are not more than 17 or 18 miles apart. In addition to the Morro da Mina and the Wigg the present producers include the Rodeio, east of Miguel Burnier, the Cocuruto, southwest of Lafayette, and the Queluz das Minas, near the Morro da Mina. There are also many abandoned or inactive ones, among which are the Piquery, Sao Gonçalo, Agua Limpa, and Barrosa mines in the Lafayette district and the Bocaina, Rodrigo Silva, and Tripuy mines in the Miguel Burnier-Ouro Preto district.

The rocks underlying the portion of Minas Geraes in which the manganese and iron ores occur are all of supposed Pre-Cambrian age. They have been classified as follows, as already described at greater length in our issue of August last:

PROBABLE ALGONKIAN.

Itacolumi quartzite. Mainly quartzite, but locally containing schists of various kinds, mostly argillaceous.

Piraçicaba schist and quartzite. In the lower part mainly schist with lenses of iron formation and carbonate rock. In the upper part contains much quartzite.

Itabira iron formation. A banded hematitic quartzite, known as itabirite, with local beds and lenses of hematite and occasional beds of ferruginous schist.

Batatal schist. Grey and red argillaceous schist.

Caraça quartzite. Quartzite with locally much sericite schist.

PROBABLE ARCHÆAN.

Gneiss, granite, and schist.

The iron ore is associated principally with the Itabira iron formation, although a few small deposits occur in iron-formation lenses near the base of the Piraçicaba schist. The manganese ore of the first type described above occurs in Archæan gneiss, granite, and crystalline schist; those of the second type occur in the upper part of the Itabira iron formation and in the lower part of the Piraçicaba schist, being frequently associated with iron ores.

The complex distribution of the various sedimentary rock formations through the central part ot Minas Geraes is due in part to irregularity in original deposition, but more especially to extensive folding and faulting, followed by erosion. A profound unconformity separates the sedimentary rocks from the underlying crystalline complex. In general, the metamorphosed sediments extend as a belt of varying width from central and southern Minas Geraes northward and slightly eastward into Bahia. This belt is characterized by a prominent mountain chain, the Serra do Espinhaço. which contains some of the highest peaks and ridges in this part of Brazil. Its prominence is due largely to the superior resistance to weathering of the Caraça quartzite, which is in area by far the most extensive of the metamorphosed sediments. The iron formation generally occurs in well-marked foothills along the sides of the quartzite ridges, though locally, where well developed and especially hard, it forms the main ridges, while the quartzite occurs on the slopes. The Piraçicaba schist, being soft, is inconspicuous topographically, but the Itacolumi quartzite forms a number of conspicuous peaks and ridges. The mountainous region of metamorphosed sediments is bounded by an irrégular, undulating region of hills and valleys, underlain by rocks of the crystalline complex. This is most typically developed east and southeast of the sedimentary belt.

(1) THE CRYSTALLINE-COMPLEX ORES. — Manganese ores are found in the crystalline complex as large irregular bodies of manganese oxide, enclosed in, or bounded by, gneiss, granite, or crystalline schist. Individual masses, such as that at Morro da Mina, may be several hundred yards in the larger diameter. While irregular in shape, they are usually somewhat elongated, suggesting lenses. They occur scattered through the crystalline complex without any apparent regularity, but most of them appear tó have either gneiss or crystalline schist on one or both bounding walls. The manganese oxide composing these lenses is usually in the amorphous form, occurring mainly as psilomelane and wad, though pyrolusite also is found. According to detailed studies made by Dr. O. A. Derby, it appears that these oxides are surface-decomposition products resulting from the weathering of other manganese minerals, which, in one or two cases, notably in the Piquery mine, have been encountered below the zone of oxidation. Of these minerals the principal ones are tephroite (the manganese-olivine) and spessartite (the manganese-garnet); and with these occur rhodochrosite (the carbonate of manganese), and sparingly rhodonite (the manganese-pyroxene). These minerals are intricately intermixed in varying proportions, one being more abundant in one place and another elsewhere; and together they form a reddish manganese silicate and carbonate rock, in general appearance like quartzite, being hard and dense with platy structure. The relation of the manganese rock to the enclosing crystalline rocks has not been definitely determined; it may be interlayered with the gneiss or crystalline schist, or perhaps intrusive into them.

From the one or two instances noted it is judged that all the manganese - oxide deposits in the areas of the crystalline complex are surface-oxidation products of such masses of manganese silicate and carbonate rock. In many of the deposits where the original rock has not been encountered, the oxide ores have textures which are duplicated in the manganese silicate and carbonate rock elsewhere, and therefore suggest a similar origin for such deposits. In the Morro da Mina mine, where the original rock has not yet been found, the massive black ore of the upper levels passes with depth into a lustrous black ore that shows minute isolated specks of spessartite in a ground-mass of amorphous manganese oxide (psilomelane). Dr. Derby concluded that this ground-mass was formed by the alteration of the more readily decomposed tephroite and rhodochrosite, specks of spessartite remaining unaltered. During the process of decomposition, more or less solution and re-deposition has taken place, with the result that certain portions of a deposit are composed of high-grade manganese oxide, while other portions contain admixtures of other products of decomposition, such as clay and silica. Most of the ore is hard, but soft material, mainly wad and pyrolusite, also occurs in abundance, irregularly intermixed with the hard ore.

The following are average analyses of ore from the Lafayette district, occurring in the crystalline complex.

	Piquery Mine, Per Cent.	Sao Gonçalo Mine, Per Cent.
Mn	49·00 to 51·00	50·00 to 52·00
SiO_2	5·00 to 7·00	1·00 to 2·00
P	0·08 to 0·10	0·12 to 0·15
Moisture	3·00 to 5·00	3·00 to 5·00

(2) THE SEDIMENTARY ORES. The manganese-ore deposits in the sedimentary series occur as definite beds associated with iron formation. The principal bed, that on which the Wigg mine is situated, is 2 or 3 miles in length, and at its maximum reaches a thickness of over 6 ft. It strikes east-west, parallel with the strike of the enclosing sediments, and corresponds with them in dip, making it apparent that the manganese-ore bed was laid down as a sedimentary bed like the enclosing rocks. The bed at the Wigg mine is bounded on one side by soft silicious iron-formation, with a contact zone of mixed soft crystalline hematite and manganese oxide, and on the other side by a ferruginous schist associated with the iron formation. The dip is generally steep, varying on both sides of the vertical.

The manganese-ore bed at the Rodeio mine is of smaller longitudinal extent, but of greater thickness than that at the Wigg mine and shows less definitely

Map of part of Brazil showing position of Manganese Deposits.
(1) Babia ; (2) Miguel Burnier-Ouro Preto ; (3) Lafayette ; (4) Corumba.

its relation to the enclosing rocks. In the vicinity of both of these deposits, beds of carbonate rocks, consisting of a mixture of calcium, magnesium, iron, and manganese carbonates, are found, but at different horizons from the manganese-ore beds.

The manganese ores associated with the sedimentary rocks consist of finely crystalline or amorphous manganese oxides, probably largely a mixture of pyrolusite and psilomelane. From their occurrence it must be assumed that they are similar in origin to the associated rocks, that is, that they are original sedimentary deposits of manganese oxide which have been somewhat altered and re-crystallized by subsequent metamorphism. The source of the manganese is doubtful, but it may very well have been derived from deposits of manganese ore in the crystalline complex. Decomposition of such deposits may have yielded a large amount of residual manganese oxide, which was worked over, transported, and deposited as beds or lenses in the sedimentary series. Their origin would, therefore, be very similar to that of the iron ores with which they are closely associated.

The ores associated with sedimentary rocks are of somewhat better grade than those occurring in the crystalline complex. The following are typical analyses of the ore obtained from the Wigg mine:

	Average per cent.
Mn	50·00 to 54·00
SiO_2	1·00 to 2·00
P	00·1 to 0·03
Moisture	15·00 to 20·00

For the benefit of readers seeking other references to Brazilian ores we may mention the following articles: 'The Manganese Ores of Brazil,' Herbert Kilburn Scott, Iron & Steel Institute 1900; 'The Original Type of Manganese-Ore Deposits of the Queluz District, Brazil,' O. A. Derby, *American Journal of Science*, 1901 and 1908; 'The Manganese Deposits of Bahia and Minas Geraes,' J. C. Branner, Transactions American Institute of Mining Engineers 1899; 'Cost of Transporting Manganese Ores in Brazil,' D. Rocha, *Engineering and Mining Journal*, March 18 1911.

TUNGSTEN ORES IN THE FEDERATED MALAY STATES.

The demand for tungsten has encouraged the search for wolfram in the Malay Peninsula. In our issue of November last, Henry Brelich described deposits in Trengganu, a British protectorate on the east side of the peninsula. We have this month received a paper read by J. B. Scrivenor, Government Geologist, before the Chamber of Mines at Ipoh, Perak, on March 25, describing the distribution of tungsten ores in the Federated Malay States.

The total amount of tungsten ore produced during 1915 throughout these States was 291 tons, of which 158 tons came from Selangor, 75 tons from Negri Sembilan, and 58 tons from Perak. The amounts reported for export were for wolfram: Selangor 183 tons, Perak 48 tons, Negri Sembilan 3 tons, total 234 tons; for scheelite: Selangor 53 tons, Perak 4 tons, total 57 tons; total wolfram and scheelite 291 tons. The total figures for production and export are identical, but the figures for the individual States show considerable variation owing to the fact that mixed tin-tungsten concentrates are not all treated for the separation of the minerals in the State in which they are produced. In interpreting these figures, it is interesting to note that the State producing the smallest amount of tin, Negri Sembilan, produced a greater amount of tungsten concentrate than Perak, the leading tin producer, and that

Selangor produced more than the other States together. Negri Sembilan's production is higher than that of Perak in spite of the fact that no scheelite was produced, which is probably because the only known limestone is in a district not producing tin ore. Again, Selangor, although a smaller tin-producer than Perak, produced nearly four times more wolfram and more than twelve times as much scheelite.

In Pahang both wolfram and scheelite are known to occur, but the only official report obtainable shows that in 1913, 85 tons of inferior wolfram was exported from Ulu Pahang, and none in the two following years. Wolfram occurs in the Kuantan district, but no information is available as to any ore being worked. In Perak, wolfram is known to occur in Larut, in the Kuala Kangsar district, in Kinta, and in Batang Padang. The best known locality is near Tapah in the Batang Padang district. Scheelite occurs in Kinta. In Selangor wolfram comes from Ulu Klang, Ulu Langat (Bukit Arang), and Ulu Kanching, from some tributaries of the Serendah river, and from the hills behind Ampang. Scheelite is found at Kanching, and near the Batu Caves. It was at one time found at Ampang and Sungei Besi. Most of the scheelite produced in Selangor in 1915 came from Kanching. In Negri Sembilan and Pahang, the Titi tin mines are the largest producers of mixed ore. Small quantities are being mined on the old Sipiau land and the land adjoining the Seremban Tin Mining Co. Wolfram has been found at several places along the Bentong-Kuala Pilah road.

In the Federated Malay States a large proportion of the tungsten minerals is won from detrital material and is mixed with cassiterite, but there are some localities where they can be seen in the rock. In Perak the best known lodes are at Bukit Rumpian, south of Tapah. Here the country rock is tourmaline-granite and is traversed by small quartz-veins carrying cassiterite and wolfram. Small veins occur in granite in the vicinity of Gopeng, carrying cassiterite and wolfram. At Tronoh, wolfram was found in 1915 in small quartz veins traversing weathered shales close to granitic intrusions. The wolfram occurred sporadically and no cassiterite occurred with it. Apparently these veins are an instance of wolfram being deposited alone at a short distance from the granite junction. Wolfram has been found in a tin-bearing pipe in the Ulu of the Petai near Kampar, the country rock being granitic. In Selangor wolfram was found on the Serendah hydraulic mine in 1909. It was probably derived from small veins in granite containing cassiterite as well. In Selangor practically all the wolfram-tin ore comes from places where there is a contact of granite and schist. The quartz veins where traversing schist contain fairly pure wolfram. On the contact of granite and schist the same veins carry mixed ore, and where they continue into granite they get richer in tin and poorer in wolfram. This supports the idea of the cassiterite being precipitated at a higher temperature than the wolfram. In Negri Sembilan the Titi Tin Mining Co.'s property, during 1914, produced as the result of lode-working 90 tons of wolfram and 500 tons of tin concentrate. In Ulu Pahang wolfram has been found in the vicinity of Bentong, a well-known tin-mining centre, and a concentrate containing cassiterite and scheelite is also produced.

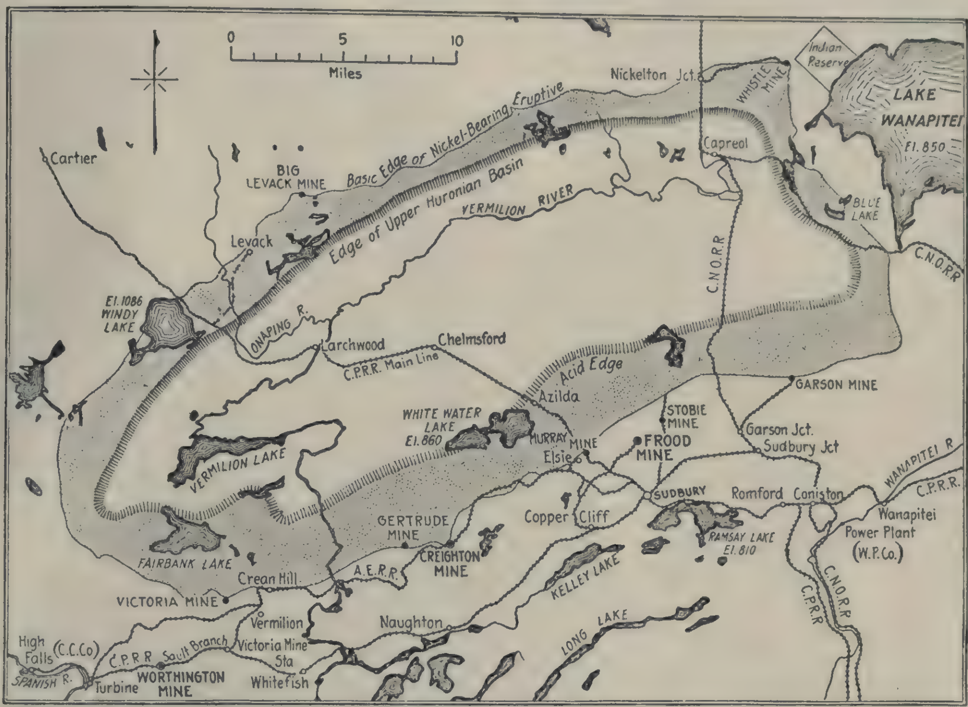
The best example of a lode containing scheelite was exposed in 1908 on the Changkat Salak Syndicate's property at Salak North. It was about 12 ft. wide and consisted of quartz with scheelite and light yellow tourmaline. A vein containing scheelite was in the Ulu Piah mine. It was encased in clay in a cleft in weathered limestone, which was undoubtedly the wall-rock originally. The scheelite was accompanied by fluorite and a little quartz. A junction between limestone and granite was close at hand. Near Pulai scheelite is now being worked close to a limestone and granite junction. The ore is all won from the residual red earth overlying the limestone, and there can be no doubt from the size and angularity of the pieces that it has been dissolved out of a limestone matrix nearby. The limestone shows slight traces of contact metamorphism, and green spinel, brown mica, and fine-flaked white mica were detected.

In the Raub gold mines in Pahang, scheelite is occasionally found in the lodes. The country rock is calcareous shale and perhaps very fine-grained volcanic ash. Scheelite was found in quantity in the old 'Raub Hole,' but that found now is of no economic importance.

THE ORIGIN OF SUDBURY NICKEL-COPPER DEPOSITS

In an article published in the *Engineering and Mining Journal* for May 6, Cyril W. Knight, Assistant Provincial Geologist for Ontario, presents additional evidence relating to the origin of the Sudbury nickel-copper deposits, evidence which appears likely to demolish the magmatic segregation theory. This theory was originally advanced in 1891 by the late Dr. A. E. Barlow, who returned to the subject in greater detail in 1901. Since his death, A. P. Coleman has championed his view. Vogt in 1892 enunciated a similar theory to explain the origin of deposits in Norway. The late J. H. Collins in 1888 attributed their origin to deposition from solutions. In more recent years, Dickson, Campbell, and Howe, as well as Richard Beck, have been on the side favouring deposition from solutions. Mr. Knight, during field work last year, examined the biggest mine of the district, the Creighton, and made observations with regard to the underlying granite which indicate a different condition from that assumed by Dr. Barlow. This deposit is found at the contact of the granite and norite, and dips at an angle of 45° to the northwest. Granite forms the foot-wall, and norite the hanging wall. The theory of magmatic segregation declares that the nickel-copper sulphides settled to the bottom of the norite and rested on the granite foot-wall. Mr. Knight found, however, that dikes of the granite penetrate the norite at a great number of places, and the inference therefore is that the norite is the older rock. Thus the granite was not the foot-wall, so that the sulphides did not sink down to it in the process of magmatic segregation. Mr. Knight's sequence of geological events begins with the norite cutting a complex of sediments and igneous rocks; then an intrusion of coarse-grained granite; then a period of ore deposition from solution. The solutions probably emanated from the norite, but on this point Mr. Knight promises a further communication at a later date.

The supporters of magmatic segregation experienced difficulties in interpreting the formations at several mines in the Sudbury district. For instance, at the Worthington, the orebody is a brecciated basic dike, and it seems clear that solutions circulated along the interstices of the fragments and blocks, and deposited the sulphides in these interstices. At the Frood mine, the sulphides are found in schistose beds of greywacke and to a less extent in norite or gabbro. The greywacke has been crushed and brecciated, and solutions have deposited the sulphides along this zone. A map of the Sudbury district is given below.



Map of Sudbury District, South Ontario, showing the Geology and the position of the chief Nickel-Copper Mines.

Flotation at Missouri Lead Mines.—We have already mentioned in our columns that flotation plant has been erected at lead mines in Missouri, particularly those owned or controlled by the St. Joseph Lead Company. In the *Mining and Scientific Press* for April 29, L. A. Delano describes the plant in use for the treatment of slime adopted by the St. Joseph company. This article is of interest, as it describes plant employed at the biggest lead mine in the United States, for most of the important American plants have been erected at copper mines. It also describes the use of filters in connection with the drying of lead concentrate, a practice that was not adopted in Australia, the home of the flotation process as applied to lead ores. In the early days all lead in the slime was lost, but later Frue vanners and slime-tables were used to treat a portion of the slime. The recovery was very small, however. The ore consists mainly of disseminated galena in a gangue of dolomite. Small amounts of pyrite, chalcopyrite, and blende are present in some of the ore. It is easily crushed and the galena slimes readily. The ore is crushed to pass through 9-mm. screens, and is treated by jigs and tables. The overflow from the classifiers is the portion treated by flotation. The Minerals Separation process was adopted, and flotation plants were built both in the Bonne Terre and the Leadwood mills. The Doe Run Lead Co., a subsidiary, also installed a plant in the Rivermines mill. The plants are similar, consisting of Dorr tanks for thickening the overflow, and a Minerals Separation machine for producing the froth.

The Bonne Terre mill produces the largest proportion of slime, approximately 20% of the ore milled. The plant consists of four Dorr thickeners 8 ft. deep and 40 ft. diameter. These handle about 2800 gallons of water per 24 hours, containing approximately 2% solids, or an average of 400 tons of dry slime per day. The slime settles readily, and the tanks maintain a clear overflow, which is used again for mill-circuit water. The thickened pulp averages 25% solids. The agitation-froth machine contains 16 compartments. The thickened pulp from the four Dorr tanks is brought by pipes to a mixing-box at the head of the machine. The pulp passes through each compartment, froth being removed from the spitz in front of each cell. The impellers are run at 290 revolutions per minute. Various speeds have been tried, but, for the power consumed, this produces as good a result as at the plants that use speeds of 320 and 350 r.p.m. The power consumed at Bonne Terre is 4·5 hp. per cell.

A crude hardwood creosote oil is used. Various oils and mixtures were tried, but none proved as satisfactory. The oil is fed to the machine in alternate compartments by a small 8-cylinder pump, driven from the line-shaft of the impeller-drive. Oil consumption is approximately 0·8 lb. per ton of dry slime treated, or a gallon of oil per ton of concentrate.

The feed to the flotation plant consists of slime of which approximately 90% is finer than 150-mesh. Material coarser than this is more economically treated on tables. The lead assay of the pulp varies at the different mills. At the Bonne Terre mill it averages

5%. The tailing from the flotation machine averages 0·7% lead. About 88% recovery is maintained. The grade of concentrate averages 52%. When the plant was installed a mechanical rake was used to remove the froth as fast as it was formed. Later this rake was abandoned, and the froth was allowed to run over the edge of the spitz, with equally good results. The froth is broken up in launders and in the pump-box by a fine spray of clear water.

The concentrate was formerly pumped to settling-vats equipped with steam-coils. When a vat was loaded, it was allowed to settle for four to five hours, the clear water was syphoned off, and the pulp dried by steam to 20% moisture. The concentrate was then shovelled into cars and shipped to the smelter. In the summer of 1915 experiments were made to find a method of handling the concentrate-pulp more economically. Settling tests showed that this pulp could be thickened from 90% moisture to about 37%. A small Oliver filter was then tried, to determine if it would treat this thickened pulp. The tests were satisfactory, cakes being formed with moistures as low as 8%. Consequently a 38 ft. by 6 ft. Dorr tank for thickening the pulp and a 12 ft. by 11½ ft. Oliver filter were installed to handle the flotation concentrate, and thus abandon the steam-drying vats. The filter was started in February 1916, and has run continuously since. The pulp pumped to the Dorr thickener contains 10% solids and is thickened to 65% solids. The pulp is fed into a well in the centre of the tank, in which a fine spray is used to break up most of the froth. A baffle-ring extends round the tank near the overflow to prevent the escape of froth. The Oliver filter receives a pulp which averages 35% moisture. The cake is fairly uniform, being about $\frac{3}{16}$ in. thick, and averaging 13% moisture. The filter is operated with a speed of one revolution in 6½ minutes, and is driven by a 2 hp. motor. The vacuum is obtained by a pump driven by a 35 hp. motor, and averages 25 inches. As yet the Bonne Terre mill has the only filter in the district. A filter-plant will be installed at both the Leadwood and Rivermines mills.

Noxious Gases in Cripple Creek Mines.—Since the gold deposits of Cripple Creek, Colorado, were discovered 25 years ago, mining operations have been seriously inconvenienced by the presence in the workings of deleterious gases. The source and origin of these gases puzzled the engineers for a long time, but it was proved beyond doubt that they emanated from the rock. Lindgren and Ransome are of opinion that they represent the last exhalations of the extinct Cripple Creek volcano. The conditions underground have been improved by the introduction of pressure systems of ventilation, which have the effect of preventing the escape of the gases from the rocks into the workings. In this connection it is well to remind readers that the barometric pressure at Cripple Creek is about 22 in., and that about ½ an inch additional pressure is sufficient to keep the gases in the rock. At the instance of the Director of the Bureau of Mines, G. A. Burrell and A. W. Gauger have recently made analyses of the gases at four of the mines, of which the Mary McKinney and the Cresson are the best known. They give their results in a paper published in the May *Bulletin* of the American Institute of Mining Engineers. Their investigations show that the rock gases do not consist solely of carbonic acid, as has usually been assumed, but that nitrogen enters largely into their composition. In unventilated sections, the atmosphere gave a wide range of analyses, the carbonic acid varying from 1 to 10%, and the oxygen from 3 to 17%, but in all cases the nitrogen content was above the normal, being sometimes over 90%. It was calculated that the excess gas in the atmosphere, above the ordinary proportions of oxygen and nitrogen, consisted as to 14% of CO_2 and as to 86% of nitrogen. How this result of analysis affects the views of Lindgren and Ransome remains to be seen.

Origin of the Diamond.—In *The Mining Journal* for May 20 and 27, David Draper and W. H. Goodchild contribute to the discussion relating to the genesis of the diamond. Various theories have been propounded accounting for the origin of diamonds in an igneous rock, but only three of these have met with much support. Bonney holds that the diamond was derived from the explosive disruption of a deep-seated diamond-bearing eclogite, and that its presence in kimberlite was accidental. Wagner is of opinion that the diamond is an original constituent of kimberlite. Orville Derby held that the diamond crystals were formed suspended in a medium sufficiently mobile or susceptible to solution as to permit their free all-round development, and that consequently the diamond must be considered a secondary mineral. The theory of the present authors relates more particularly to the growth of crystals of commercial size, following to some extent the theory propounded by Mr. Derby. They take it for granted that diamond crystals of minute size are distributed fairly widely under certain conditions, either in the rocks or in volcanic lava, and that during certain phases of the cooling of lava-flows the larger crystals grow at the expense of the smaller ones. The phenomenon of larger crystals of other soluble materials growing at the expense of smaller ones has been pointed out by several physicists, and the present authors apply the principle to the diamond. When a lava-flow has ceased, and the lava at the top of the vent has solidified, the authors hold that the contents below are subjected to the process of magmatic differentiation. The most basic parts crystallize first and fall to the bottom. Among these are the olivine which is the solvent for the diamond. Thus the diamond-bearing material is found toward the bottom of such pipes. By implication there is the chance that every extinct volcanic pipe toward its bottom may be diamond-bearing.

Diamonds in Rand Banket.—At the March meeting of the Chemical, Metallurgical, and Mining Society of South Africa, Dr. E. T. Mellor gave a description of diamonds recently found in the Rand banket at the Simmer Deep mine. These were exhibited by J. E. Thomas, and were four in number. We have already described diamonds found in the banket, notably in our issue of March 1914, when quoting from R. B. Young's paper describing the Modder B occurrence. Diamonds had previously been found at the Wolhuter and Treasury mines, and also in the Elsburg series in the Klerksdorp district.

The four stones exhibited by Mr. Thomas weigh together approximately 1⅝ carat. They are all practically complete crystals. Two are of a pale yellowish green, a third has a somewhat more decided greenish colour, especially in certain lights, while the fourth has only a very faint tinge of yellowish green. All the stones are perfectly clear and transparent. In all of them the original sharpness of the edges and the markings on the faces have been considerably modified by wear. As these particular specimens have passed through a number of machines, the smoothing of the stones might be attributed to these agencies. It is, however, much more probable that the wear is the result of natural processes prior to the deposition of the stones in the reef, as specimens from other localities which have been taken direct from the mortar-boxes have been subjected to comparatively little attrition after being freed from the rock, yet show similar evidences of wear.

In one of the Simmer Deep specimens a prominent angle of one of the stones has suffered a recent blow, which was probably a result of its passage through the mill. In this case the edges formed by numerous cleavages are perfectly sharp, and do not seem to have been modified at all by the grinding to which they were almost certainly subjected after the fracture.

With regard to the diamond from the Modder B described by Mr. Young, on Dr. Mellor's visit to the mine recently he was shown a collection of over a hundred stones. In colours these vary, from practically colourless specimens through pale yellowish green and olive green to dark bottle green. One specimen looked quite black and was opaque. Except in a few cases the stones are complete crystals. They show unmistakeable signs of wear and there can be no doubt as to their alluvial origin.

At Klerksdorp, in 1910, he was shown three small stones from a much larger number found in the Gold Estates reef. These also had the same waterworn appearance as the Rand stones. Two were almost black in appearance, but showed a dark dull green colouration when held up to the light. The smallest was of a clear light yellowish green.

The similarity of colouration shown by all the stones so far found in the conglomerates suggests that this feature may possibly have some connection with their history after leaving their original source.

The occurrence of diamonds, iridosmine, and other rare minerals with the conglomerates appears to Dr. Mellor to strengthen considerably the arguments for the alluvial origin of the gold. It tends to show that the currents which laid down the conglomerates of the Main Reef zone did actually carry such heavy minerals as are likely to travel in company with alluvial gold. He is of opinion that more careful search will probably show that such minerals are of much commoner occurrence than is yet known to be the case, but the evidence shows that they have a fairly wide distribution.

New Cornelia Leaching Plant.—We have referred on many occasions during the last year or two to the large-scale leaching plants erected at copper mines in the west of America. The Anaconda and Calumet & Arizona have already embarked on this project, and the Utah Copper is to follow. The plant now being erected for the Calumet & Arizona company at the New Cornelia mine at Ajo is described in the *Mining and Scientific Press* for April 8. The experiments leading to the adoption of leaching at the New Cornelia formed the subject of an elaborate paper by Stuart Croasdale, printed in the *Bulletin* of the American Institute of Mining Engineers for August 1914, and reproduced in the *Mining and Scientific Press* for August 8, 15, and 22 of the same year.

The New Cornelia orebody is estimated to contain 20,000,000 tons of oxidized ore averaging 1½% copper, and the plant now under construction is designed for an output of 17,500 tons of copper per year. A 9% solution of sulphuric acid is employed; the ferric iron is reduced by the action of sulphur dioxide; the precipitation of the copper is done electrolytically. The preliminary experiments on a working scale extending over many months indicated the average copper content of the ore as 1·325%, the average assay of the tailing 0·283%, the recovery 79%, and the pounds of copper deposited per kilowatt-hour 1·125. The ore will be reduced to 3½ in. in gyratory crushers, and subsequently to ¼ in. in Symons disc crushers. The crushed ore will be conveyed to eleven leaching vats, lead-lined, each 88 ft. square and 15 ft. deep, and each with a capacity of 5000 tons. The vats, together with a sludge tank of similar capacity, will be arranged in two rows, with a central structure between, which will support the conveyors and the circulating pumps. The solution from the vats will be pumped to the electrolytic deposition plant, which will contain 152 lead-lined electrolytic vats each 30 ft. long, 4 ft. wide, and 5 ft. deep. Electric power will be generated by steam turbines, and the boilers will be oil-fired.

Deep-Lead and Drift Mining.—At the meeting of the Cornish Institute of Mining Engineers held on May 27, M. T. Taylor, superintendent of East Pool mine, read a paper on the mining methods employed in working the auriferous deep leads of Victoria. The paper is a very complete one and its value is enhanced by excellent working drawings and photographs. We regret that we have not space to publish it in full, and an abstract would not do it justice.

TECHNICAL JOURNALS FOR THE MONTH

BRITISH.

Colliery Guardian.—*May 5:* Ferro-Concrete Bins for Iron Ore and Limestone at the Brymbo Ironworks, Wrexham. *May 26:* Schofield's Safety Device for Suspending Mine Cages; The Cheliabinsk Brown Coal Deposits in the Urals, A. Snyatkoff.

Cornish Institute of Engineers.—*May 27:* Deep Lead and Drift Mining, M. T. Taylor.

The Engineer.—*April 28:* Rustless Ferro-Alloys, L. Aitchison; Electric High-lift Pump at Racecourse Mine, Staffordshire. *May 5:* British Machinery and the Russian Market—IV., P. Gurewich. *May 12:* Electrical Winding Plant for the Pumpherston Oil Co., Scotland. *May 19:* Reinforced Concrete Pipes for Conveying Water. *May 26:* Mineral Railway in Durham Operated by Electric Current Generated by Waste Gases of Blast-Furnaces and Coke Ovens; Diversion of River Don at Hadfield's Steel Works, Sheffield.

Engineering.—*May 12:* Gas-heated Melting Furnaces.

Faraday Society.—*May 9:* Changes in the Physical Properties of Aluminium with Mechanical Work, F. J. Brislee; The Annealing of Aluminium, R. Seligman and P. Williams.

Imperial Institute Bulletin.—*January - March:* Salt Deposits of Cyprus; Diatomite from Australasia; Occurrence and Utilization of Zinc Ores—II.; Utilization of Peat—II.

Institution of Petroleum Technologists.—*May 16:* Petroleum Refining, Andrew Campbell.

Iron and Coal Trades Review.—*May 19:* Rearrangement of Ventilation Systems at Wallsend and Hebburn Collieries, C. A. Nelson. *May 26:* Standard Nomenclature and Specifications for Tar and Pitch, as used for binding purposes on roads and in agglomerating coal and other materials; New Coke-Oven Plant at Bell Brothers Ironworks, Middlesbrough.

Iron and Steel Institute.—*May 4:* The Heat Treatment of Chrome Steel, C. A. Edwards; The Theory of the Corrosion of Steel, L. Aitchison; Influence of Carbon and Manganese on the Corrosion of Iron and Steel, Sir R. A. Hadfield and J. Newton Friend.

Manchester Geological and Mining Society.—*May 9:* Application of Microscopical Examination to the Determination of Coking Properties of Coal, James Lomax.

The Mining Journal.—*May 20:* Mining in Bolivia; Notes on the Genesis of the Diamond, David Draper and W. H. Goodchild [continued May 27].

The Physical Society.—*May 26:* Viscosity of Colloidal Solutions, E. Hatschek.

Royal Society of Arts.—*May 24 and 31:* Zinc, its Production and Industrial Applications, J. C. Moulden.

COLONIAL.

Canadian Mining Institute Bulletin.—*May:* Control of Mineral and Metal Industries within the British Empire, W. H. Trewartha-James; Canadian Gold and War Finance, Adam Shortt; Carbonizing and Briquetting of Saskatchewan Lignite, S. M. Darling.

Canadian Mining Journal.—*April 15:* The Kowkash Gold Area, P. E. Hopkins; Sampling and Assaying of Molybdenum Ores as practised by the Orillia Company, Canada, B. C. Lamble. *May 1:* Gold Mines of Northern Ontario, a review of gold mining operations throughout the province; Geological Features of the Porcupine Gold Area, A. G. Burrows; Treatment of Porcupine Gold Ores; Metallurgy at Tough Oakes Mine, C. A. Randall.

Chemical, Metallurgical, and Mining Society of South Africa Journal.—*February:* Dust-Sample Tubes, F. W. Watson; Non-flammable Explosives Bags, F. W. Pursglove; The Conglomerates of the Witwatersrand, E. T. Mellor. *March:* Modification of the Dowsett Regulator for the Underflow of Classification Cones, E. H. Johnson; Uranium, Niobium, and Tantalum Minerals in Madagascar, T. P. Waites; Analysis of Niobium-Tantalum Minerals, James Moir; Some New Methods of Testing for Molybdenum, James Moir.

Geological Society of South Africa Transactions.—*Year 1915:* Occurrence of Radio-active Minerals in South Africa, A. W. Rogers; Geology of Part of Namaqualand, A. W. Rogers; Zinc-Lead Ore Deposits near Zeerust, W. Anderson.

Mining and Engineering Review (Melbourne).—*April:* The Bendigo Goldfield, and its Undeveloped Resources, W. H. Cundy.

Queensland Government Mining Journal.—*April:* Annan River Co.'s Pumping Plant at Cooktown Tinfield; Oil Shales and Coal at Sugarloaf, L. C. Ball.

South African Mining Journal.—*April 1:* First Aid in the Mines of the Rand—A Proposal; The Earth Tremors Committee's Report [continued in issues of April 8 and 22]. *April 8:* Future Producers of the Far East Rand—The Lace Proprietary Mines; Amortization Calculations in connection with Share Values. *April 15:* Map of the Far East Rand, after Hatch and Mellor; Engineering Requirements of South Africa, and the extent to which they can be manufactured locally. *April 22:* The Rand Selection Corporation.

FOREIGN.

American Institute of Mining Engineers Bulletin.—*May:* The Manganese Ores of Russia, India, Brazil, and Chile, E. C. Harder; The Emerald Deposits of Muzo, Colombia, Joseph E. Pogue; The Rifling of Diamond-Drill Cores, W. R. Crane; The Solution of Some Hydraulic Mining Problems on Ruby Creek, British Columbia, Chester F. Lee and T. M. Daulton; Composition of the Rock Gas of the Cripple Creek Mining District, G. A. Burrell and A. W. Gauger; Radio-activity of Allanite, L. S. Pratt; Decomposition and Reduction of Lead Sulphate at Elevated Temperatures, W. Mostowitsch.

Economic Geology.—*January:* Paragenesis of Certain Sulphide Intergrowths: Wolframite and Scheelite at Leadville, Colorado, R. S. Fitch and G. F. Loughlin; The Role of Colloidal Migration in Ore Deposits, J. D. Clark and P. L. Menaul; Aluminium Hydrates in the Arkansas Bauxite Deposits, D. C. Wysor.

Far Eastern Review (Shanghai).—*March:* The Ping-Siang Colliery, Kiang-Si, China.

Franklin Institute Journal.—*May:* Recent Progress in Flotation, R. J. Anderson.

Engineering and Mining Journal.—*April 23:* The Concentration of Tungsten Ores in Colorado, J. F. Magee; Mining in British Guiana, Frank Fowler; the Kellow Rotary Rock-drill as used in Spain, a drill hydraulically operated and invented some years ago by Moses Kellow of the Croesor slate quarries, North Wales. *April 29:* The Mining Industry of Brazil, B. Leroy Miller and J. T. Singewald; The Control of Ore Slimes, O. C. Ralston [continued in issue of May 20]; The Black Hills Gold-bearing Iron-Quartz-Tremolite Belt, B. M. O'Harra; Shaft-sinking Methods at Sudbury Mines, A. E. Hall. *May 6:* Chloridizing-Leaching Plant for Treating Pyrite Cinders at the Works of the Virginia Smelting Co., F. A. Eustis; Origin of Sudbury Nickel-Copper Deposits, C. W. Knight; Estimating Metallic Aluminium in Aluminium Dust, J. E. Clennell. *May 13:* The Mining History of Peru, J. T. Singewald and B. Leroy Miller; How Flotation Works, G. D. Van Arsdale. *May 20.* Mechanical Feeding at Silver-Lead Blast Furnaces at Midvale, Utah, L. Douglass Anderson; The Oatman Gold-mining District, Arizona, Leroy A. Palmer.

Engineering Magazine.—*May:* Mono-rails and Gravity Conveyors, R. L. Streeter.

Iron Age.—*April 13:* Powdered Coal in the Open-Hearth Furnace, C. J. Ladd. *April 20:* Steel Industry of Europe after the War, H. H. Campbell. *May 4:* Rennerfelt Electric Arc Furnace, C. H. Vom Baur.

Journal of Geology.—*April-May:* Prismatic Structure in Igneous Rocks, R. B. Sosman; the late Orville A. Derby, John C. Branner.

Metallurgical and Chemical Engineering.—*May 1:* Water-Power Conference of the American Institute of Electrical Engineers; Report of Meeting of American Electro-Chemical Society; Report of Meeting of the American Chemical Society; Application of Centrifugal Force to Suspensions and Emulsions; Niagara Falls Power and American Industries; Calculating the Burden of the Blast-Furnace, J. E. Johnson; Cost Accounting in the Construction and Operation of a Copper Smelter, E. E. Thum [continued May 15]; The Grading Industries, E. S. Wiard [continued May 15]; Recent Progress in Electrolytic Iron, O. W. Storey. *May 15:* Symposium on Cyanidation of Flotation Concentrates; Effect of Vacuum Fusion on Magnetic Properties of Pure Open-hearth Iron, T. V. Yensen; Electrolysis of Alkaline Solutions of Potassium Sulphocyanate; Blast-Furnace Operation, J. E. Johnson.

Mining and Engineering World (Chicago).—*April 22:* Copper Mining at Jerome, Yavapai county, Arizona, W. P. de Wolf. *April 29:* The Marysville Mining District, Montana, L. S. Ropes; Braden Roasting and Sulphuric Acid Plants, J. B. Wise. *May 6:* Hydro-electric Plants for Mines in British Columbia, F. C. Perkins; Sulphuric Acid Manufacture in the United States, W. H. Waggaman. *May 13:* The Discovery of the National Gold Mine, Northern Nevada, Horace V. Winchell.

Mining and Scientific Press.—*April 15:* Need of

Change in the Patent Law, J. M. Hyde; Smelting Plant at Anaconda, L. S. Austin; Geology of the Cottonwood District, Utah; Rapid Method for Estimating Tungsten, M. L. Hartmann. *April 22:* Concentration of Zinc Ore at the Thompson Mine, Wisconsin, H. P. Wherry; Oils for Flotation, C. Y. Clayton and C. E. Peterson. *April 29:* Flotation Principles, O. C. Ralston; Mining in Jerome District, Northern Arizona, C. F. Willis; Prospecting before Dredging on Seward Peninsula, Alaska, C. C. Brayton; Flotation Practice in Missouri, L. A. Delano; Working Data on Electrolytic Precipitation, P. H. Crawford; Cyanidation at Comacaran mine, Salvador. *May 6:* Cyanidation of Flotation Concentrate, P. W. Avery; Surficial Indications of Copper, F. H. Probert; Double Roasting Process at East Helena. *May 13:* Fine Grinding: Stamps and Ball Mills, H. Hanson; Vistas del Peru, H. E. West; Quicksilver Reduction, Herbert Lang; Soap as a Frothing Agent in Flotation, M. H. Thronberry.

NEW BOOKS AND OTHER PUBLICATIONS

Hydraulic Flow Reviewed. By Alfred A. Barnes. Cloth, octavo, 160 pages, with many diagrams. London: E. & F. N. Spon. Price 12s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The calculation of the flow of water in pipes and in open channels often causes considerable trouble to the mining engineer, for the amount of water conveyed and discharged is difficult to deduce from the dimensions and the slope, while giving due attention to the nature of the surface over which the water flows. Half-a-dozen investigators have given an equal number of formulæ, which are widely divergent in their results and range of application. The author has had reason, in the course of his professional work, to study the question critically, and he has been able to evolve a more accurate variation of the formula. If our scope covered civil engineering problems, we should give a close and reasoned review of this book. As it is, we content ourselves with recommending readers who are confronted with these problems to give the book their best attention.

'The Times' Book of Russia: Finance, Commerce, Industries. By E. St. John Brooks, and an introduction by Sir Donald Mackenzie Wallace. Cloth, octavo, 260 pages, with seven maps. London: *The Times*, Printing House Square, E.C. Price 2s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This handy and compact volume, edited by E. St. John Brooks, the compiler of *The Times* Russian Supplement, comprises a summary of the business knowledge of modern Russia and Siberia. It will prove invaluable to mining engineers and business men making trips to the Russian Empire for the first time, and it contains also much that is of interest to those who are fairly familiar with that country. As stated in the preface, it is based largely on material that has appeared from time to time in *The Times* Russian Supplement since its first publication in December 1911, and special attention has been paid to the subjects of finance, industry, and commerce. Foreign trade and shipping, trade routes, tariffs, textile industries, general engineering, mineral resources, agriculture, forestry and timber resources, fisheries, social conditions, education, the position of women, and peasant industries are all treated in a brief and business-like form.

As Sir Donald Mackenzie Wallace says in the introductory remarks, the volume has the twofold aim of stimulating the steadily increasing interest taken by the British public in all that concerns Russia, and of helping the reading public to understand "how we may, as a nation, resist the insidious attempts of the Germans to monopolize Russian trade, and how we may help our ally to develop her vast natural resources."

Of the eighteen chapters on various subjects, four are devoted to the mineral industries and resources of Russia and Siberia. This portion of the book has been edited by Mr. C. W. Purington. This fact at once makes the book attractive to the mining engineer.

The production of cotton and the development of cotton manufactures is ably treated. Tobacco is exported from Russia to the amount of over 10,000 tons annually. The annual output of the beet-sugar factories averages 1,800,000 tons annually, or half the total amount produced in other European countries. Silk is produced annually to the extent of 2,500,000 lb. in the Russian Empire. Much silk from Russia is exported to France in the form of cocoons.

In fisheries Russia is said to equal if not exceed any other country in the value of the product. The fishing industry cannot be said to be intensive, and the magnitude of the future of this industry may be imagined. Although the depletion of Russian forests has hardly begun, it is a fact that 60,000,000 tons of wood fuel are annually consumed in the country. Important paper and wood-pulp industries are already developed. Over 400,000 tons of paper was manufactured in Russia and Finland during 1912.

Some shrewd comments are contained in this book that will aid the prospective trader in the Russian Empire. The seven excellent maps are helpful. The letter-press and binding are good. Altogether this is about the most useful book on Russia that we have seen.

The Mechanical Handling and Storing of Material. By George Frederick Zimmer. Large octavo, 10½ in. by 7½ in., 750 pages, 1000 illustrations. London: Crosby Lockwood & Son. Price 42s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The professional literature devoted to mining and metallurgy is deficient in information relating to the mechanical engineering problems that confront the mining man. Probably the reason for this is that the societies and the technical press think the manufacturers of appliances ought to disseminate the information themselves, the societies considering that makers' catalogues are more suitable for this purpose than bulletins or transactions, and the technical journals arguing that the proper place for the announcements is in their advertising columns. The last remark may be taken as a reflection on ourselves, but we would hasten to remove such an impression, and to say that we are always keenly desirous of publishing information as to the performance of mechanical plant of all classes when supplied by the users after due experience. This, however, by the way.

Mr. Zimmer wrote a book some years ago on the mechanical handling of material, and now presents us with an enlarged and extended edition covering storing also. The subject is a big one and cannot be treated in detail in one volume, however large. Consequently the illustrations, though numerous, are on a small scale and the descriptions are brief. We should have been glad if a lighter paper had been used, and not so much of the page occupied by margin, so as to bring the book to portable size and weight. As it is the volume weighs over six pounds, and the weight and the price are both far too great.

It is impossible within the space at our disposal to describe in any complete manner the scope and contents of the book. The first section is devoted to mechanical conveyors of all kinds and used for various purposes. These chapters are followed by accounts of pneumatic and hydraulic conveyors, and here we miss any reference to the conveyance of filling for exhausted stopes. The next section contains descriptions of ropeways. The author omits reference to a system of haulage of interest to mining engineers, namely, that of Pretorius using the single rope for supporting carriers travelling in both directions. The following chapters deal with skips, buckets, grabs, transporters, grain elevators, and coaling apparatus for ships, railway engines and cars, etc. Other chapters contain information relating to the storage of coal, ores, etc., and automatic methods of weighing. Throughout the book the German practice is largely quoted, and many of the words are used in the German sense. For instance, we are not accustomed to calling an ore-bin a 'silo.' In conclusion we may safely say that out of the mass of information contained in the book some part of it will be of interest to every engineer.

Oil and Petroleum Manual for 1916. This is the seventh annual issue of a handbook prepared by Walter R. Skinner, giving information relating to oil companies in the same way that his 'Mining Manual' deals with the coal and metal mining companies. Details of 650 companies are given. The published price is 2s. 6d. net.

YEARLY REPORTS OF MINING COMPANIES

Golden Horse-Shoe Estates.—This company was formed in 1894 to acquire a prospect at Kalgoorlie, Western Australia. Production commenced in 1899, and for eleven years the yield and dividends were well maintained, averaging 160,000 oz., and £250,000 per year respectively. In 1910 the ore reserves showed a fall in quantity and average contents, and only £75,000 was distributed that year. Nothing was paid for 1911, 1912, and 1914; £60,000 was paid for 1913 and £82,500 for 1915. The report for the year 1915 shows that 243,564 long tons of ore was raised, as compared with 284,496 tons the year before. The yield of gold by amalgamation was worth £105,275, by the treatment of 66,352 tons of residues by cyanide £18,336; by cyaniding 158,578 tons of slime £206,510, and by roasting and cyaniding 18,634 tons of concentrate £115,571. In addition, cyanide slag sold for £2171, bringing the total revenue to £448,046. As already mentioned, £82,500 was paid as dividend, being at the rate of 2s. 6d. per £5 share. J. W. Sutherland, the manager, reports that the No. 4 lode, the lode containing the richest ore, has been cut on the 3020 ft. level, where 134 ft. has been driven north and 174 ft. south, the ore averaging 98s. and 31s. respectively over the width of the drift. The decrease in the ore mined was caused by the shortage of labour, and unfortunately the position in this respect is not improving. The reserve in No. 4 lode is estimated at £173,037 tons, averaging 13·1 dwt. per ton, and the total in all four lodes at 704,359 tons, averaging 9·21 dwt.

Gopeng Consolidated.—This company was formed in 1912 as a consolidation of the Gopeng and the New Gopeng, two companies with offices at James Wickett's at Redruth, that had for some years previously been treating tin gravels in Kinta district, Perak, Federated Malay States. The consolidation was arranged in order to facilitate the financing of a plan for providing a new water-supply from the Kampar river, conjointly with the Kinta Tin Company. The report for the year ended September 30 last shows that the new water-supply became available in March 1915, and that thereafter the output of tin concentrate gradually increased, until in September it was double that of the monthly output at the beginning of the year under review. The year's output was 681 tons, selling for £61,702. The company continued to operate the Ulu Gopeng property belonging to the Berwick estate. The yield at this property was 72 tons, selling for £6243, out of which £1968 accrued as profit to the company. The total profit for the year was £44,632, out of which £24,489 was distributed as dividend, being at the rate of 6⅔%.

Tekka.—This company was formed in 1907 by James Wickett, with headquarters at Redruth, to acquire the Sungei Raia alluvial tin property in the Kinta district of Perak, Federated Malay States. Osborne & Chappel are the managers. Substantial dividends have been paid regularly. The report for the year ended January 31 shows that the output was smaller by 90 tons as compared with the previous year, owing to the ground treated having been much harder. The yardage was 432,700, and the output of tin concentrate 401 tons. The accounts show an income of £36,488 from the sale of produce, and a working profit of £21,712, out of which £21,000 was distributed as dividend, being at the rate of 5s. 3d. per £1 share. The year before, £24,000 was distributed.

Tekka-Taiping.—This company was formed as a subsidiary of the Tekka for the purpose of acquiring a tin-gravel property at Taiping in the district of Larut, Perak, Federated Malay States. James Wickett is chairman, and the office is at Redruth. The report for the year ended October 30 last shows that the suction dredge worked under difficulties owing to a landslide, which damaged the barge and necessitated its removal to a new position. The amount of tin concentrate won was 234 tons, extracted from 337,100 cu. yd., the yield per yard being 1·56 lb. The Werf Conrad bucket-dredge commenced work on September 18, and began digging on October 23, just before the end of the year under review. The capacity of this dredge is 40 tons of concentrate per month. It is intended to suspend work with the suction dredge whenever the next mishap occurs, and then to rely solely on the bucket-dredge. The profit for the year was £6646, which was written off the account as part value of the suction dredge. Since the close of the company's financial year, two dividends have been paid, together equal to £6192, or 10% on the capital.

Tronoh Mines.—This company was formed in 1901 to acquire alluvial tin properties in the Kinta district of Perak, Federated Malay States. At the time of the formation of the company, the office was at Redruth and James Wickett was secretary. The actual control was left in the hands of the original vendors, E. G. Edgar and Foo Choo Choon. After six years of prosperity, the methods of mining had to be altered. The English board took control, the office was moved to London, and H. D. Griffiths was appointed manager. Another series of profitable years then ensued. Three years ago the richer gravels began to show signs of exhaustion, so that once more the methods of treatment had to be re-considered. Bucket dredging was adopted on parts of the property. The report for the year 1915 shows that 1817 tons of tin concentrate was produced, as compared with 1539 tons in 1914, 2187 tons in 1913, and 2776 tons in 1912. The revenue from the sale of concentrate was £174,047, and the profit was £29,311, out of which £16,000 has been paid as dividend, being at the rate of 10%. The year 1914 showed a loss of £20,109; for 1913 the dividend was 37½%, and for 1912 75%. The chief producing property was the South Lombong, from which 275,995 cu. yd. yielded 835 tons. At No. 3 mine 121,160 cu. yd. was treated for a yield of 123 tons. Tributers working on the company's ground obtained 580 tons. No. 1 dredge was set to work on tailing in July, but the results have been disappointing, partly owing to breakdowns and partly to the low yield per yard. No. 2 dredge was started in January 1915 on No. 5 area. During the year under review it handled 790,869 yards for a yield of 258 tons. As regards the future the South Lombong property is rapidly nearing its end and the output for 1916 is likely to show a considerable reduction. Systematic boring has been conducted on No. 6 area, and the results so far indicate that the erection of a dredge may be warranted. For the last two years J. H. Rich has been manager.

Tronoh South.—This company is a subsidiary of the Tronoh Mines, and was formed in 1911 to acquire alluvial tin properties in the Kinta district of Perak, Federated Malay States. Operations were started in 1912, but as the results were not good, the plant was removed to another section of the ground. The report for the year 1915 shows that work has been confined to a clay lead, which is being worked by open-cut, the removal of a large amount of overburden being necessary. The lead dips to the south, and is now 50 ft. below the surface as compared with only 20 ft. at the north end. It is passing into the ground of the Tronoh Mines, and its extension in that property is to be worked on tribute. During the year 1915 the amount of ground treated was 123,000 cu. yd., from which 318 tons of concentrate was won. In addition 268,100 cu. yd. of overburden was removed. The accounts show an income of £31,248 and a net profit of £4908. The shareholders received £5000, or 5%. Prospecting by boring has proved the presence of tin-bearing sandy gravel to the east of the clay lead, and this area is amenable to treatment by a bucket-dredge.

Idris Hydraulic Tin.—This company is a subsidiary of the Tronoh Mines, and was formed in 1913 to acquire an alluvial tin property in the Kinta valley, Perak, Federated Malay States. The report for the year 1915 shows that 206,000 cubic yards of gravel was treated at the Batu Karang property, for an output of 132 tons of tin concentrate. At the Snudong property, 34 tons was obtained from 130,000 cu. yd., and at the Kranji 62 tons was obtained from 152,000 cu. yd. Tributers, working mostly on lodes, won 110 tons of concentrate. The accounts show a profit of £7373, out of which £6000 has been paid as dividend, being at the rate of 5%. It will be seen that the results at Snudong have been disappointing. At the other properties, however, the outlook is satisfactory. The hydro-electric plant was completed in November last, but owing to drought the full benefit has not yet been obtained.

Sungei Besi Mines.—This company is a subsidiary of the Tronoh Mines, and was formed in 1909 to acquire an alluvial tin property in the district of Kuala Lumpur, Selangor, Federated Malay States. Operations were started in 1914. The report for the year 1915 shows that 263,340 cubic yard of gravel was treated, and 653 tons of tin concentrate won, this being a yield of 5½ lb. per yard. The income was £63,396, and the net profit £32,280. This balance has been applied to the reduction of the debentures and the loan from the Tronoh Mines. The parent company has taken 25,000 shares in part settlement for capital advanced. Profits since the end of the year under review have been used to redeem the remaining debentures and discharge the balance of the debt to the parent company.

Esperanza Sulphur & Copper.—The company was formed in 1906 to acquire the Esperanza, Forzosa, and Angostura pyrite mines, in Huelva province, southern Spain. T. D. Lawther is managing director. Small dividends were paid for the years 1908 to 1912, on the capital £350,000. At the time of the formation of the company, £100,000 debentures were issued to the vendors, and up to the end of 1915, £56,990 had been redeemed. A month ago it was decided to redeem the balance of the debentures, £43,010. The report for the year 1915 shows that a smaller amount of ore was mined owing to the decrease in demand caused by the war, but that the actual amount of ore shipped from Huelva was not much less than during 1914. At the Angostura mine, 41,774 tons was mined, as compared with 47,426 tons in 1914, and at the Esperanza and Forzosa 44,514 tons was mined, as compared with 63,497 tons. The reserves are estimated at 307,000 tons at the Angostura, and 431,000 tons at the Esperanza-Forzosa, falls of 33,000 tons and 52,000 tons respectively as compared with the figures a year ago. The copper precipitate produced during the year was 135 tons. The shipments of ore from the port of Huelva were 89,224 tons, 9527 tons less than during the previous year. The trading profit for the year was £25,680, out of which £2183 was paid as debenture interest. The remainder, with the balance from the previous year, was devoted to the redemption of the outstanding debentures, as already mentioned.

Rezende Mines. — This company was originally formed in 1892 as the United Gold Fields of Manica for the purpose of acquiring a gold-mining property near Umtali, Rhodesia, not far from the boundary of Portuguese East Africa. The results were generally disappointing and several reconstructions were necessary. In 1908 the control passed to the Anglo-French-Farrar group. In 1912 the adjoining property of the Penhalonga company was absorbed, which for an equal length of time, under a different control, had been similarly unprofitable. After the amalgamation profits were made, and a dividend was paid for 1912. The Penhalonga is now exhausted, and operations are confined to the older properties, the Central and Old West Workings. The office of the company was two years ago transferred to that of Farrar Brothers. The report for the year 1915 shows that at the Central section 57,600 tons of ore averaging 7·2 dwt. was raised, and that 19,125 oz. of gold was extracted, being 6·64 dwt. per ton. At the Old West Workings 63,900 tons of ore, averaging 2·87 dwt., yielded 6492 oz. or 2·03 dwt. per ton. The revenue at the Central was £81,750, and the working profit was £15,085. At the old West Workings the revenue was £28,312 and the working profit was £5441. The aggregate working profit was £20,527, out of which £13,324 has been distributed as dividend, being at the rate of 11¾%. The profit was less than that for the year 1914, owing chiefly to the yield of the ore at the Central mine being 2s. 1d. lower. The ore reserve on December 31 was calculated at 84,245 tons averaging 7 dwt. in the Central section and 279,439 tons averaging 3 dwt. in the Old West Workings. The development during the year has not been so favourable in the Central mine, as a smaller proportion of the ore disclosed is payable. Ten of the Penhalonga stamps are to be erected at the Old West Workings, where ore of rather higher grade but of harder character is to be treated.

West Rand Consolidated.—This company belongs to the Albu group, and was formed in 1903 to acquire a number of properties in the far west Rand. In 1907 the Violet mine and mill were purchased, and in 1915 part of the property of the Lancaster West company was bought. The property now includes workings on the Botha or Main Reef series to the north, and on the Battery series to the south. Milling commenced in 1908, and further plant has been added since. As the development has given good results lately, a plan has been formulated for again increasing the treatment plant, but the present time is not considered suitable for embarking on the new enterprise. In the meantime, however, two additional tube-mills are being erected. The report for the year 1915 shows that 423,561 tons of ore was raised. Of this, 209,948 tons came from the west workings on the Main Reef, 69,916 tons from the east workings of the Main Reef, 104,222 tons from the Rand shaft of the Battery Reef, and 39,475 tons from development. After the rejection of 12·8% waste, 369,400 tons was sent to the mill. The extraction by amalgamation was 66,601 oz., and by cyanide 40,295 oz., being a total of 106,896 oz., worth £448,730. The yield per ton milled was 5·78 dwt. or 24s. 3d. The working cost was £355,200 or 19s. 2d. per ton milled, leaving a working profit of £93,530 or 5s. 1d. per ton. Out of the profit, £26,980 was paid as debenture interest, £10,975 as profits tax and war levy, and £4447 to the Miners' Phthisis Fund. The shareholders receive no dividend. The only distribution was 3¾% in 1909. The share capital is £2,004,424, and there are £444,410 debentures. The development during the year added 385,000 tons to the reserve, which on December 31 stood at 1,838,380 tons, averaging 6·1 dwt. over a stoping width of 52 in. In addition 255,793 tons of partly developed ore is estimated to average 6·4 dwt. per ton.

Princess Estate & Gold.—This company was formed in 1888 to acquire property in the west Rand, in the Roodepoort district. In 1911 deep level properties were purchased from the Roodepoort Central Deep and West Roodepoort Deep companies. The control is with the Goerz group. Milling commenced in 1892. Dividends were paid in 1897 and 1899, and from 1908 to 1911. The capital issued is £575,033, and £19,248 has been advanced by A. Goerz & Co. The report for the year 1915 shows that 353,559 tons was mined, of which 11% was sorted underground and 15% on the surface. The mill, now containing 60 stamps and 5 tube-mills, treated 268,500 tons averaging 6·18 dwt. per ton. The yield by amalgamation was 61,388 oz., and by cyanide 18,952 oz., making a total of 80,340 oz., worth £339,777, or 25s. 3d. per ton. The working cost was £338,931, or 25s. 2d. per ton, leaving a working profit of £846. The outcrop sections are practically exhausted, and if the output is to be maintained, more development will have to be done in the deep-level sections. At the present time the Central Deep is the only section where anything like satisfactory ore is being found. The future of the property gives rise to anxious consideration.

Durban Roodepoort.—This company has its office in London, and P. A. Molteno is chairman. It is not connected with any of the big houses of the Rand. The mine is in the middle west Rand, and is notable as having been the only one in that district to pay continuous dividends. The end of its life is in sight, and H. Ross Skinner, the consulting engineer, estimates that the reserve will last for two years. The report for 1915 shows that 196,667 tons was raised, and after the rejection of 13% waste, 170,831 tons was sent to the mill. The yield of gold by amalgamation was 31,564 oz., and by cyanide 9391 oz., making a total of £172,337, or 20s. 2d. per ton milled. The working profit was £34,890, or 4s. 6d. per ton, and £31,250 was distributed to shareholders, the dividend being at the rate of 25%. The ore reserve on December 31 was estimated at 326,526 tons, expected to yield £1 per ton. Since the beginning of operations in 1888, the total yield has been worth £4,880,912, and the total distribution £1,447,583, being 1175% on the capital.

Durban Roodepoort Deep.—This company belongs to the Rand Mines group and owns property in the west Rand on the dip of the Durban Roodepoort and Roodepoort United. Milling commenced in 1898, and the first dividend was distributed in 1908. The profits have never been on a large scale, and the dividends have only totalled 62½% on a capital of £440,000. A few years ago the water difficulty became serious and interfered with development, but the provision of a new pumping installation has made the conditions more favourable. Shaft-sinking is now proceeding at an increased rate, and it will in future be possible to do more development on the richer South Reef. The report for the year 1915 shows that the tonnage and output of gold were rather higher than during the two preceding years, and in fact constituted records for the mine. On the other hand the yield per ton was slightly less, and the working cost showed an increase, so that the working profit was not maintained. During the year 369,806 tons was raised, and after the rejection of 13% waste, 320,830 tons averaging 6·9 dwt. per ton was sent to the mill. The extraction by amalgamation was 68,776 oz. and by cyanide 34,209 oz., making a total of 102,985 oz., worth £426,699, being a yield of 26s. 7d. per ton. The working cost was £374,647 or 23s. 4d. per ton, leaving a working profit of £52,051 or 3s. 3d. per ton. The shareholders received £33,000, the rate being 7½%. The development disclosed 319,090 tons of ore, and at December 31 the reserve was estimated at 977,700 tons averaging 6·3 dwt., together with 312,300 tons averaging 7·4 dwt. left in pillars. The reserve was about equally divided between the Main and South Reefs.

Roodepoort United Main Reef.—This company belongs to the Albu group and owns outcrop and deep-level properties in the West Rand. It was formed originally in 1887, and there have at various times been rearrangements and amalgamations. In 1908 the Kimberley Roodepoort was absorbed, and in 1910 a part of the deep levels was transferred to the New Steyn Estate Co. Dividends were paid from 1894 to 1910. In the latter year, the General Mining & Finance Corporation advanced about a quarter of a million pounds for the purpose of building a modern mill and of pushing development. This debt now amounts to £312,630. The policy during the last year or two has been to mine larger amounts of the low-grade Main Reef, and thus reducing the average working cost. The report for the year 1915 shows that 448,817 tons was raised, and after the removal of 9% waste, 408,086 tons was sent to the mill, where 75 stamps and 5 tubes were working. The extraction by amalgamation was 60,333 oz., and by cyanide 27,996 oz., making a total of 88,329 oz., worth £374,612, or 18s. 2d. per ton milled. The working cost was £353,499 or 17s 4d. per ton, leaving a working profit of £21,113 or 10d. per ton. The sum of £21,117 was paid as interest on the debt, so that nothing was available for the shareholders. The ore reserve in the South Reef on December 31 was estimated at 720,309 tons averaging 5·9 dwt. per ton; in addition, 148,414 tons is classed as partly developed ore and its average content is taken at 5·17 dwt.; while 573,559 tons in the Main Reef, though no figure is given for its assay-value, is expected to yield a fair proportion of payable material. The monthly capacity is gradually being increased to 39,000 tons, and when this condition is attained the margin of profit should be greater. The alteration in the reefs in depth will have the effect of reducing the cost of development and mining. The manager, F. W. Girdler-Brown, is of opinion that the general conditions are more favourable than a year of two ago.

Bantjes Consolidated Mines.—This company was formed in 1887 to acquire property on the outcrop in the middle west Rand, but milling was not started until 1910. The Main Reef and Main Reef Leader have not been worked except to a small extent on the outcrop in the western end of the property, and the South Reef has provided most of the ore. For the last three years the development has given discouraging results, and a year ago it was decided to stop exploration on the South Reef and devote attention to the Leader. Arrangements were made with the Main Reef West company, owning deep-level ground on the east, whereby a level was driven from the adjoining ground into the Bantjes ground at a point 600 ft. below the lowest Bantjes level. We have already published details of this exploration work, and it is only necessary here to say that the results so far obtained are distinctly encouraging. The report for the year 1915 shows that 256,559 tons of ore was raised, and after the rejection of 8·7% waste, 235,400 tons of ore averaging 5·7 dwt. per ton was sent to the mill. The yield by amalgamation was 33,488 oz., and by cyanide 29,961 oz., being a total of 63,449 oz., worth £262,764, or 22s. 4d. per ton milled. During 1912, the ore milled was 286,453 tons, the yield £423,021, and the yield per ton 29s. 6d. During the year under review the working cost was £253,342, or 21s. 6d. per ton, leaving a working profit of £9421, or 10d. per ton. The development done during the year exposed 123,650 tons of payable ore, less than half the normal yearly output, and on December 31 the reserve was estimated at 648,000 tons averaging 6·1 dwt. per ton, of which 142,800 tons was in the Leader and 505,200 tons was in the South Reef. The future of the company causes a great deal of anxiety to shareholders. The control is with Rand Mines.

Aurora West United.—This company belongs to the Albu group, and was formed in 1891 to acquire an outcrop property in the middle west Rand, to the east of the Bantjes and above the Main Reef West. Milling was commenced in 1892, but was suspended in 1894. Another start was made just before the Boer war, but afterward milling was not resumed until 1908. Reconstructions were necessary in 1895, 1909, and 1912, and additional funds have been borrowed from the parent company, the General Mining & Finance Corporation. No dividend has been paid. The report for the year 1915 shows that 200,639 tons was raised, and after the rejection of 14% waste, 172,491 tons was sent to the mill. The Main Reef Leader and the South Reef supplied the greater part of the ore, in about equal quantities, but a notable amount was also obtained from the Main Reef in old stopes below the foot-wall of the Leader. The yield of gold by amalgamation was 34,917 oz. and by cyanide 14,949 oz., making a total of 49,866 oz. worth £209,325, or 24s. 2d. per ton milled. The working profit was £44,081 or 5s. 1d. per ton. Out of this profit, £29,285 was spent on shaft-sinking and on the purchase of a tube-mill. The new incline shaft was completed in November. The ore reserve was estimated on December 31 at 550,044 tons averaging 5·5 dwt., as compared with 614,610 tons averaging 5·26 dwt. the year before. Development was much hindered during the year by water troubles. The debt owing to the General Mining & Finance Corporation was £80,948 on December 31.

New Unified Main Reef. — This company belongs to the Barnato group, and has been reconstructed on several occasions, with rearrangements of the property owned. The mine is to the east of the Aurora in the western Rand, mentioned in the preceding paragraph. Milling commenced in 1893, and the first dividend was paid in 1908. During the last two or three years larger amounts of low-grade ore from the Main Reef have been treated, owing to the Leader nearing exhaustion. By increasing the tonnage milled the cost per ton has been reduced, and thereby large blocks in the South Reef have come within the payable limit. The report for the year 1915 shows that 186,894 tons was raised, and after the rejection of 13% waste, 161,940 tons was sent to the stamps. The extraction by amalgamation was 23,768 oz., and by cyanide 14,860 oz., making a total of 38,628 oz., worth £164,092, or 20s. 3d. per ton milled. The working cost was £106,076 or 13s. 1d. per ton, leaving a working profit of £58,016, or 7s. 2d. per ton. Out of this profit, £50,000 was distributed as dividend, at the rate of 20%. The development done during the year disclosed ore in the Main Reef Leader averaging 12 dwt. over a stoping width of 42 in., but the amount added to the reserve was small as the Leader is now fully developed. The ore disclosed on the South Reef was patchy, and little of it will be worth stoping. The reserve on December 31 was estimated at 399,140 tons averaging 5·7 dwt. in the Leader and South Reef, and in addition 192,000 tons in the Main Reef is over the payable limit.

Village Deep.—This company belongs to the Rand Mines group, and was formed in 1898 to acquire deep level property below the Village Main Reef mine in the central part of the Rand. The Village Main Reef is itself a deep level mine, being on the dip of the Wemmer, Salisbury, Jubilee, and the City & Suburban. In 1908 additional ground to the south was purchased from the Turf Mines company, and a new vertical shaft, known as No. 3, was sunk for the purpose of serving the ground acquired. A year ago the development report was excellent, the reserve having been fully maintained, and the ore disclosed during the year having been above the average. The report for the year 1915 now issued does not have so favourable a tale to tell, for though the ore proved is of the same grade as a year ago the amount of ore disclosed was only 360,600 tons, or about a half-year's output. In addition, however, 348,000 tons has been partly developed, but its value not yet estimated. The ore developed in the Main Reef Leader has given satisfaction, but the results in the South Reef have been relatively unfavourable. The total reserve on December 31 was estimated at 2,631,600 tons, averaging 6·6 dwt., of which 2,336,900 tons, averaging 6·8 dwt., was in the Leader, and 294,700 tons, averaging 5·4 dwt., was in the South Reef. During the year under review, 719,654 tons of ore was raised, and after the rejection of 13% waste, 622,200 tons, averaging 7 dwt., was sent to the mill. The extraction by amalgamation was 146,269 oz., and by cyanide 67,613 oz., making a total of 213,882 oz., worth £886,222. The yield per ton milled was 6·87 dwt., or 28s. 6d. The working cost was £590,395, or 19s. per ton milled, leaving a working profit of £295,827, or 9s. 6d. per ton. As compared with the previous year the ore milled was 21,800 tons more, the yield per ton 7d. higher, and the cost per ton 1s. 4d. higher. Out of the profit, £225,392 was distributed as dividend, being at the rate of 21½%, the same as the year before.

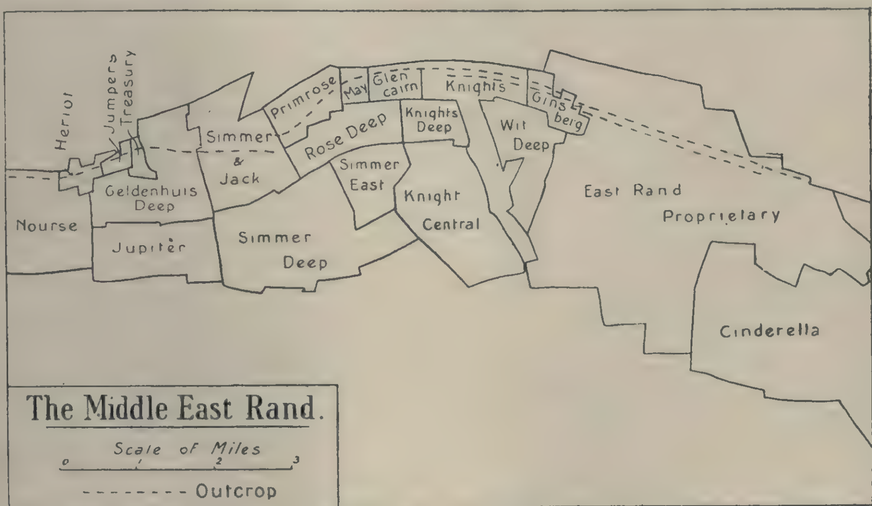
New Goch.—This company, belonging to the Albu group, was originally formed in 1887 as the George Goch to acquire claims on the outcrop in the central Rand, between the Wolhuter and the Nourse. There have been several reconstructions and rearrangements and the only dividends paid have been for 1910, 1911, and 1915. The debentures were finally extinguished a year ago by the application of £112,475 accumulated profit to the purchase of the outstanding amount. The report for the year 1915 shows that 415,910 tons of ore was raised, and after the rejection of 12½% waste, 363,200 tons averaging 4·85 dwt. per ton was sent to the mill, which contains 100 stamps and 4 tubes. The extraction by amalgamation was 53,595 oz., and by cyanide 25,759 oz., a total of 79,354 oz., worth £333,121, being a yield of 18s. 4d. per ton milled. In addition £13,148 was extracted from accumulated slime, bringing the total revenue to £350,038. The working cost was £254,913, or 14s. per ton. The working profit was £95,125, out of which £55,000 was distributed as dividend, being at the rate of 10%. The ore reserve was calculated on December 31 at 668,600 tons, averaging 5·5 dwt., over an average stoping width of 82 in. In addition 80,963 tons of partly developed ore is estimated to average 4·68 dwt. A year ago the proved reserve was calculated at 825,896 tons, averaging 5·27 dwt. Owing to faulting, the development during the year has not given so large a proportion of ore to the work done as usual. Only a small amount of ground remains to be developed, the lowest level, the 19th, is now being driven, and the main shaft has reached the south boundary.

City & Suburban.—This company has its office in Natal, but the technical control is with the Central Mining & Investment Corporation. It was formed in 1887 to acquire an outcrop property in the richest part of the central Rand. Dividends have been paid continuously since 1888. A small amount of additional ground was purchased in 1913 from the City Deep in order that the deepest part of the property should not end in a point. This ground is now being developed, and is yielding ore of excellent grade. The report for the year 1915 shows that the reserves are being depleted, and that the upper levels have been largely stripped of any remaining ore. The amount of ore mined during the year was 380,397 tons, and after the removal of 11% waste, 337,023 tons averaging 37s. 7d. was sent to the mill. The yield of gold by amalgamation was 100,819 oz., and by cyanide 44,637 oz., making a total of 145,456 oz., worth £606,809, or 36s. 1d. per ton milled. The working cost was £356,929, or 21s. 3d., leaving a working profit of £249,880, or 14s. 10d. per ton. The shareholders received £187,000, the dividend being at the rate of 11s. per £4 share. The development during the year disclosed 159,200 tons in the Main Reef Leader, but work in the Main Reef and South Reef was uniformly disappointing. The ore reserve on December 31 was estimated at 539,600 tons in the Leader averaging 38s. 8d. per ton, and 97,800 tons in the South Reef averaging 8 dwt. per ton. Of the total, 440,200 tons is available for current stoping, and 197,200 tons is in shaft pillars. Compared with the figures a year ago, the reserve shows a fall of 121,300 tons. A large amount of low-grade ore remains in the mine, and eventually some of it may be raised and treated.

New Heriot.—This company was formed in 1887 under Natal laws to acquire a small property on the outcrop in the central Rand, and the control is the same as that of the City & Suburban mentioned in the preceding paragraph. The technical management is also in the hands of the Central Mining & Investment Corporation. The report for the year 1915 shows that 191,953 tons was raised, of which 105,749 tons came from the South Reef, 55,520 tons from the Main Reef Leader, 27,136 tons from the Main Reef, and 3548 tons from the North Reef. After the rejection of 18% waste, 155,900 tons averaging 36s. 11d. per ton was sent to the mill. The extraction by amalgamation was 45,424 oz., and by cyanide 21,240 oz., making a total of 66,664 oz., worth £279,490, or 35s. 11d. per ton milled. The working cost was £169,609, or 21s. 9d. per ton, leaving a working profit of £109,881, or 14s. 1d. per ton. Out of the profit, £86,250 was distributed as dividend, being at the rate of 75%. The ore reserve was calculated on December 31 at 536,680 tons averaging 33s. 7d., of which 283,362 tons averaging 33s. 7d. was in the Main Reef Leader, 167,113 tons averaging 36s. 1d. was in the South Reef, and 86,205 tons averaging 26s. 10d. was in the Main Reef. These figures are less by 51,635 tons as compared with a year ago. The mine is now practically fully developed. The upper levels are being reopened with the object of reclaiming pillars, and probably the resources in these levels, together with the reserves at the bottom of the mine, will keep things going for five years yet.

Geldenhuis Deep.—This company belongs to the Rand Mines group, and was formed in 1893 to acquire property on the dip of the Geldenhuis in the eastern part of the Central Rand. Excellent dividends were paid for many years. In 1909 the remains of the outcrop mine were absorbed, as was also the Jumpers Deep. The combined property was not, however, able to supply ore to the 420 stamps, and since then only 300 have been at work. Moreover the development has given less favourable results of late years, with a consequent shrinkage of profits. The report for the year 1915 shows that 730,970 tons of ore was raised, and after the removal of 12½% waste, 639,800 tons averaging 6·45 dwt. per ton was sent to the mill. The yield by amalgamation was 113,794 oz. and by cyanide 62,491 oz., making a total of 196,285 oz., worth £813,800, being an extraction of 25s. 6d. per ton. The working cost was £685,200, or 21s. 6d. per ton, leaving a working profit of £128,600 or 4s. per ton. As compared with the previous year, the yield per ton was 1s. 11d. less, and the cost per ton was 1s. 4d. per ton less. Out of the profit, £117,150 was paid as dividend, being at the rate of 20%. The ore reserve on December 31 was calculated at 1,826,800 tons averaging 6·1 dwt., as compared with 1,613,000 tons averaging 6·4 dwt. the year before. The reason for the increased tonnage is that the decrease in working cost has brought certain blocks of low-grade ore within the scope of profitable mining. During the year the north section of the property was re-opened with a view of reclaiming the pillars.

Rose Deep. — This company belongs to the Rand Mines group, and was formed in 1894 to acquire property on the dip of the New Primrose in the middle east Rand. In 1909 an amalgamation was effected with the adjoining Glen Deep which owned the mine on the dip of the May and Glencairn. During recent years trouble has been caused from time to time by caving. During 1915 a serious cave occurred in No. 3 section, which has been closed in consequence, for the time at any rate. The report for 1915 shows that 912,068 tons was raised, and after the rejection of 13% waste, 789,700 tons averaging 6 dwt. was sent to the mill. The extraction by amalgamation was 147,505 oz. and by cyanide 80,999 oz., making a total of 228,504 oz. worth £945,948, or 24s. per ton milled. The working cost was £667,645 or 16s. 11d. per ton, leaving a working profit of £278,303, or 7s. 1d. per ton. The shareholders received £227,500, being 32½% on the capital. The development during the year has given uniformly disappointing results in all the reefs, Main, Leader, Bastard, and South, and the 470,181 tons added to the reserve has been of so low grade as to reduce the average content substantially. The total reserve on December 31 was estimated at 3,605,390 tons averaging 5·2 dwt. per ton. There is no likelihood of any improvement taking place in the developments in future. As the tonnage milled is being increased, a reduction of cost may to some extent compensate for the fall in grade.



The Middle East Rand.

May Consolidated Gold.—This company was formed in 1887 to acquire claims on the outcrop in the middle east Rand, and additional properties were bought in 1889 and 1894. Milling was begun in 1888, and the equipment was gradually increased until 1896, when 100 stamps were at work. The control is now with the Goerz group. The report for 1915 shows that the mine is at an end as a regular producer, though it is expected that the mill will continue to work, on a small scale, during the current year. During 1915 the amount of ore raised was 181,765 tons, and after the rejection of 7½% waste, 168,320 tons averaging 4·1 dwt. per ton was sent to the mill. The yield by amalgamation was 17,454 oz., and by cyanide 12,790 oz., making a total of 30,244 oz., worth £127,987, or 15s. 2d. per ton, The working cost was £117,957 or 14s. per ton, leaving a working profit of £10,030 or 1s. 2d. per ton. A year or so ago the company purchased 28,875 shares in Modderfontein Deep, and the dividend accruing for 1915 was £10,106. The total working profit of the company was therefore £20,793, out of which £14,437 was distributed among shareholders, being at the rate of 5 per cent.

New Primrose Gold.—This company was formed in 1887 to acquire claims on the outcrop in the middle east Rand, and milling was commenced in 1888. In 1891 the South Primrose property was absorbed; in 1893 the Moss Rose and Moss Rose Extension mines and mills were purchased; and in 1894 the May Deep mine and mill were purchased. The company has paid excellent dividends, but the end is now in sight. The control is with the Barnato group, and H. L. Krause is manager. The report for the year 1915 shows that 251,992 tons was raised, and together with 7308 tons from the dump, was sent direct to the mill without sorting. The average assay of the ore was just under 4½ dwt. per ton, or 1 dwt. less than the year before. The yield by amalgamation was 35,493 oz., and by cyanide 18,630 oz., making a total of 54,123 oz., worth £229,946, or 17s. 8d. per ton milled. The working cost was £160,849, or 12s. 5d. per ton milled, leaving a working profit of £69,097, or 5s. 3d. per ton. The shareholders received £56,875, the dividend being at the rate of 17½%. The ore reserve on December 31 was estimated at 265,623 tons averaging 5½ dwt. per ton, and there is also a large amount of ore that can be won by reclamation. The work during the year was hindered by extensive caving, consequent on severe floods in the early months of the year. It will be difficult in future to maintain a regular output.

Glencairn Main Reef.—This company belongs to the Barnato group, and was formed in 1889 to acquire the western part of the Witwatersrand Gold Mining Co.'s property in the middle east Rand. Milling was started in 1890, and dividends were first paid in 1894. After the Boer war distributions were not resumed until 1906, and since then the dividends have been small. The mine is now nearing its close, and the grade of the ore mined is low. The report for the year 1915 shows that the reserve on December 31 was calculated at 117,430 tons averaging 4·4 dwt. per ton, and that in addition 365,140 tons is near the border line of payability. Further ore will also be obtainable by reclamation. During the year, 281,014 tons was raised, and after the rejection of 10% waste, 251,940 tons was sent to the mill. The average assay-value of the ore milled was 3·63 dwt. The yield of gold by amalgamation was 26,080 oz. and by cyanide 13,605 oz., making a total of 39,685 oz., worth £186,638, or 13s. 5d. per ton milled. The working cost was £146,921, or 11s. 3d. per ton, leaving a working profit of £21,716, or 1s. 9d. per ton. The shareholders received £27,500, or 5%.

Ginsberg Gold.—This company belongs to the Barnato group, and owns an outcrop property in the middle east Rand immediately to the west of the East Rand Proprietary. Milling commenced in 1894, and dividends were paid from 1897 to 1905, except during the Boer war. In the latter year the mill was destroyed by fire, and the Balmoral company's mill was then leased. In 1907 the Balmoral property was absorbed. Payment of dividends was resumed in 1908. The report for the year 1915 shows that the Ginsberg section is fully developed and is nearing exhaustion. The north section has been re-opened, and the development has given good results. During the year 219,913 tons was raised, of which 60% came from the North section. After the removal of 16% waste, 185,764 tons averaging 5.58 dwt. was sent to the mill. The yield by amalgamation was 27,349 oz. and by cyanide 21,034 oz., making a total of 48,383 oz., worth £205,508, or 22s. 2d. per ton milled. The working cost was £162,660 or 17s. 6d. per ton, leaving a working profit of £42,847 or 4s. 8d. per ton. The shareholders received £31,500 or 15%. The reserve on December 31 was estimated at 278,118 tons averaging 5.67 dwt. per ton, and a large amount of ore still remains to be reclaimed. Of the tonnage mined during the year about 43% was obtained by reclamation.

Knight Central.—This company was formed in 1895 to acquire a 'second-deep' property in the east Rand below Knight's Deep. The control is with the Neumann group. Milling commenced in 1909, and the first and only dividend was paid for 1910. The ground is intersected by the great Simmer dike, and the part below the dike is now being developed. In our Review of Mining we have from time to time during the last few months referred to promising but vague announcements as to the results of this development. The report for the year 1915 gives results of development up to January 31. It is stated that on the 17th level a cross-cut from the west auxiliary shaft reached the Main Reef and the South Reef. On the South Reef, 85 ft. on the east and west drifts from the cross-cut assayed 8½ dwt. over 66 in.; and on the Main Reef a length of 60 ft. averaged 7.6 dwt. over 72 in. The policy is to continue the sinking of the east and west auxiliary shafts in order to prove the mine at greater depth. During the year under review, 368,910 tons was mined, and after the rejection of 13% at the underground sorting station, 326,385 tons of ore was hoisted and sent direct to the mill. The yield of gold by amalgamation and cyanide was £347,879 or 21s. 4d. per ton, and the working cost was £302,445 or 18s. 6d. per ton, leaving a working profit of £45,433, or 2s. 9d. per ton. Most of the profit was employed in shaft-sinking. The development in the ground north of the dike during the year exposed 218,100 tons of ore, and the reserve on December 31 was estimated at 406,400 tons averaging 5.84 dwt. No estimate can be made of the resources below the dike.

Witwatersrand Gold.—This company owns the mine usually known as Knight's on the outcrop in the east Rand, and extending also a long way southward on the dip between Witwatersrand Deep on the east and Knight's Deep and Knight Central on the west. The control is with the Barnato group. Milling commenced in 1888, but was suspended from 1891 to 1896 pending further development. In 1910 it was decided to develop the deep-level section, and a shaft was accordingly sunk 3000 ft. south of the outcrop. Excellent dividends have been paid since 1905. The report for the year 1915 shows that 597,021 tons of ore was raised, and after the rejection of 15% waste, 504,800 tons was sent to the mill. The extraction by amalgamation was 111,500 oz., and by cyanide 40,673 oz., making a total of 152,173 oz., worth £646,581, or 25s. 7d. per ton milled. The working cost was £372,330, or 14s. 8d. per ton, leaving a working profit of £274,251. The shareholders received £234,812 as dividends, being at the rate of 50%. The ore reserve on December 31 was estimated at 1,480,423 tons averaging 6.83 dwt. over a stoping width of 60 inches.

Witwatersrand Deep.—This company belongs to the Neumann group, and was formed in 1895 to acquire a deep-level property in the east Rand on the dip of Ginsberg and Witwatersrand Gold, and to the west of the East Rand Proprietary. Milling started in 1902, and the first dividend was paid in 1906. The report for the year 1915 shows that the ore developed below the 'water' dike continues to show lower assay-values than the ore above, with a resulting shrinkage of profits. The amount of ore raised was 576,660 tons, and after the removal of 10% waste, 519,292 tons was sent to the mill. The gold extracted by amalgamation was worth £474,806, and by cyanide £184,003, making a total of £658,810, or 25s. 4d. per ton milled. The yield per ton in 1914 was 26s. 1d., and in 1913 28s. 11d. The working cost was £444,970, or 17s. 1d. per ton, leaving a working profit of £213,839, or 8s. 2d. per ton. The shareholders received £158,125, the dividend being at the rate of 28¾%. During the year 375,437 tons averaging 6.3 dwt. was added to the reserve, but on the other hand some blocks had to be omitted from the previous year's estimate owing to further development having proved their content to be below the payable limit. The reserve on December 31 last was calculated at 1,673,000 tons averaging 6 dwt., as compared with 1,707,400 tons averaging 6.2 dwt. the year before. The west subsidiary shaft has been sunk to the boundary, and future developments in depth will be confined to the eastern section of the property. J. E. McGuire is manager.

Nigel Gold.—This company was formed under Natal laws in 1887 to work a gold deposit at Heidelberg in the Transvaal. The reef is now proved to constitute the southern outcrop of the basin of the Far East Rand. Milling commenced in 1888, and excellent dividends were paid in the early days. During the last few years the rate of distribution has been smaller. Last August the reserve in the Western section came to an unexpectedly abrupt termination, and it was suggested that milling should be suspended and all energies devoted to development in the Marais Nigel ground. Eventually it was decided to keep the mill working at reduced capacity and to conduct development on double shift. The results obtained by this development work have been satisfactory. A shoot has been proved in the 11th, 14th, and 22nd levels east of No. 3 shaft. The shoot appears to be 300 ft. long, and to assay 11 dwt. over 36 in. It is expected that stoping will commence on this shoot in December next. The upper levels in the Marais ground are to be developed by means of a new incline shaft. During the year 1915 the mill treated 135,100 tons averaging 7.14 dwt. per ton, for a yield of 25,243 oz. by amalgamation and 18,790 oz. by cyanide, making a total of 44,033 oz. In addition 418 oz. was recovered from accumulated sand. The total revenue from the sale of gold was £186,571, and the working profit was £14,545, out of which £11,155 was distributed as dividend, being at the rate of 5%. This dividend was declared before it was known that the reserve in the Western section was on the point of exhaustion.